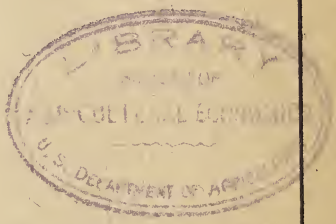
UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT ON THE AGRICULTURAL EXPERIMENT STATIONS, 1932



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UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF EXPERIMENT STATIONS

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REPORT ON THE AGRICULTURAL EXPERIMENT STATIONS, 1932

By J. T. Jardine and W. H. Beal[1]

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INTRODUCTION

The broad purpose of the agricultural experiment stations, as stated in the Hatch Act, is—

> to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science.

This report indicates some of the ways in which the experiment stations are fulfilling this purpose and gives examples of the service they are rendering to agriculture and rural life during a period of declining financial support and of increasing demands for aid.

The report shows how the funds available for the support of the State experiment stations and those of Alaska, Puerto Rico, Guam, and the Virgin Islands during the year ended June 30, 1932, were used and what were some of the more significant results of their work during the year, particularly from the standpoint of practical application and service. The information was obtained by personal examination of the work and expenditures of the stations, through direct communications from the directors, and from publications of the stations. (See p. 10.)

The report also gives information on personnel, facilities for research, research programs and projects and their coordination and readjustment, and other matters pertaining to the organization, administration, and progress of the stations.

As shown later in the report, substantial progress was made during the year in developing the intensive and productive scientific research that is basic to the improvement of practice, in more efficient use of limited resources, and in aiding to solve some of the more immediate and acute problems arising out of the depressed condition of agriculture.

[1] With the collaboration of other members of the office staff.

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FINANCIAL SUPPORT

The financial support of the experiment stations for the year ended June 30, 1932, amounted to $17,245,163.83, as compared with $18,056,282.07 the preceding year, when the station revenues reached their highest point. Of the total, $4,587,030 was derived from appropriations under the Hatch, Adams, and Purnell Acts and from appropriations made by Congress for the support of the stations in Alaska and the insular possessions; the remainder came from State and other sources as shown in table 1.

TABLE 1.—*Income of the experiment stations from all sources for the fiscal years 1931 and 1932*

Source of funds	1931	1932
Hatch Act	$735,000.00	$750,000.00
Adams Act	725,000.00	727,000.00
Purnell Act	2,880,000.00	2,880,000.00
Appropriations for insular stations	250,200.00	230,030.00
State appropriations and allotments	9,166,554.19	9,501,097.10
Fees	630,455.23	434,424.62
Sales receipts	1,618,219.64	1,311,711.64
Miscellaneous income	548,613.58	589,509.12
Balance from previous year	1,502,239.43	821,391.35
Total	18,056,282.07	17,245,163.83
Income 1931 over that of 1932	811,118.24	

That portion of the income of the experiment stations for the fiscal year 1932 that was derived from other than Federal sources amounted to $12,658,133.83, or to 73.4 percent of their total revenue. An increase of $334,542.91 in State appropriations and allotments over the amounts in 1931 was more than offset by a decrease of $502,538.61 in sales receipts and fees and a reduction of $680,848.08 in the balances carried forward.

The distribution of these supplementary funds by States is shown in table 2.

TABLE 2.—*Income of the experiment stations from other than Federal sources for the fiscal years 1931 and 1932*

Station	1931	1932	Station	1931	1932
Alabama	$259,113.15	$200,256.89	Nevada	$8,664.28	$9,510.55
Arizona	110,074.99	113,894.76	New Hampshire	55,769.45	50,626.23
Arkansas	138,533.66	112,441.49	New Jersey	894,178.75	721,277.66
California	1,080,740.42	1,203,083.54	New Mexico	61,321.20	51,350.41
Colorado	173,372.11	163,712.14	New York Cornell	840,149.91	937,362.95
Connecticut State	250,865.19	265,641.19	New York State	401,054.59	485,345.66
Connecticut Storrs	65,195.06	55,431.66	North Carolina	187,412.16	141,605.86
Delaware	41,100.32	37,148.87	North Dakota	221,506.29	211,641.55
Florida	497,548.66	360,497.66	Ohio	1,051,913.48	1,162,788.18
Georgia	38,119.84	39,135.07	Oklahoma	193,145.76	204,140.36
Hawaii	41,894.98	30,148.69	Oregon	293,103.54	241,616.80
Idaho	52,930.31	52,021.58	Pennsylvania	163,497.29	166,779.82
Illinois	531,055.82	482,392.59	Rhode Island	6,896.55	6,209.52
Indiana	759,186.89	657,694.98	South Carolina	128,408.79	131,467.80
Iowa	302,862.93	301,695.80	South Dakota	56,794.62	48,823.25
Kansas	197,373.50	217,958.02	Tennessee	66,503.45	44,436.84
Kentucky	400,437.70	308,363.83	Texas	589,663.04	557,663.81
Louisiana	187,128.92	141,368.27	Utah	101,897.03	95,485.57
Maine	87,105.04	58,521.62	Vermont	24,197.86	24,011.87
Maryland	132,372.86	119,905.70	Virginia	128,039.28	129,685.99
Massachusetts	291,540.29	277,943.28	Washington	151,277.19	126,560.63
Michigan	372,048.40	350,694.93	West Virginia	141,525.65	107,929.29
Minnesota	405,321.18	399,311.37	Wisconsin	449,745.84	441,532.73
Mississippi	170,690.16	34,401.42	Wyoming	97,632.30	85,889.85
Missouri	176,061.98	143,624.22			
Montana	148,239.98	133,025.82	Total from other than Federal funds	13,466,082.07	12,658,133.83
Nebraska	240,869.43	214,075.26			

Table 1 shows in brief that the total income of the experiment stations, including those of Alaska, Hawaii, Puerto Rico, Guam, and the Virgin Islands, declined from $18,056,282.07 in 1931 to $17,245,163.83 in 1932. The decrease in total income of the State experiment stations was $790,948.24, and of the Alaska and insular stations $20,170. The most significant facts are that there was an actual increase in State appropriations and allotments for the experiment stations during the year and that the former ratio of about $3 from State and other local sources to $1 from Federal sources was maintained.

A more detailed statement of income and expenditures will be found on pages 50–62.

FACILITIES FOR RESEARCH

The value of additions to buildings and equipment for experiment station use declined from $2,565,317 in 1931 to $1,885,003 in 1932. The amount reported as expended for buildings used in part or exclusively by the stations was $1,131,710 in 1932 as compared with $1,478,152 in 1931; for scientific apparatus, $220,300 in 1932 as compared with $350,847 in 1931; for farm implements and machinery, $205,845 in 1932 as compared with $224,145 in 1931; for livestock, $133,522 in 1932 as compared with $151,193 in 1931; for library purposes, $55,281 in 1932 as compared with $65,222 in 1931; and for miscellaneous purposes, $138,343 in 1932 as compared with $295,755 in 1931. These figures indicate sharp economies in expenditures for buildings, equipment, and similar purposes, to leave a maximum for maintenance of staff and service.

Some of the major additions to buildings and other permanent equipment are noted hereafter.

BUILDINGS

The building progam of the experiment stations was restricted to the more urgent requirements of the work in progress or called for under pevailing conditions. Some of the more important structures completed during the year had been provided for a year or more previously.

The Jenkins laboratory at the Connecticut State station was completed during the year at a cost of $70,000. This new building, which houses the departments of entomology, botany, forestry, and plant breeding, is especially well adapted to laboratory and office purposes.

The new horticultural building of the University of Maryland, in which the experiment station largely shares, was erected at a cost of $150,000 and was dedicated during the year.

The North Dakota experiment station completed a greenhouse, 20 by 63 feet, divided into three sections and equipped with automatic heating and ventilating control, four refrigeration chambers with accurate regulation of temperature, and a head house with general laboratory facilities. This station also rebuilt a steer-feeding shed and added an annex for animal-nutrition investigations, improvements much needed in studying animal-industry problems of the State.

A new dairy building for the Pennsylvania college and station, costing $500,000, affords the station greatly increased facilities for research in dairy manufacture and allied subjects.

The Virginia Polytechnic Institute dedicated, at the beginning of the year, a new dairy husbandry building costing about $150,000, with three stories and basement, affording, among other facilities, extensive dairy-manufacturing and other laboratories, a complete refrigeration plant, and similar equipment for the use of the experiment station.

At the New Hampshire station a new dairy barn housing the station herd was occupied, and the Idaho station commenced rebuilding its dairy barn, partly destroyed by fire on April 21.

Smaller additions to building equipment were reported by a number of other stations. The Georgia station undertook the construction of a fireproof cattle barn to cost about $2,200. The horticultural department of the South Carolina station was provided with additional facilities in a new laboratory and storage building, and the poultry division of the Arkansas station with a new poultry plant costing about $6,000 and accommodating about 1,000 laying hens.

The New York Cornell station built a sheep barn housing about 250 ewes and providing storage for hay and grain, remodeled an old barn for taking care of experimental flocks, affording room for 125 feeder lambs and a like number of ewes, and made other improvements in facilities for experiments in animal husbandry.

LAND AND SUBSTATIONS

The provisions by State legislatures to supply land and other facilities for the study of local and regional problems were supplemented by the action of public-spirited citizens having the progress of agriculture and the betterment of country life at heart.

A gift of 750 acres near Pomona, Calif., with a stud of 87 Arabian horses and an endowment of $600,000, was accepted by the University of California under an agreement to establish an institute of animal husbandry. This institute, as a part of the division of animal husbandry, will have as its primary function the breeding and improvement of the Arab horse and will offer opportunities for genetic and breeding investigations with other animals, as well as research in other fields of animal science. The same donor presented to the Michigan college and station a tract of 360 acres near Battle Creek for demonstrating the proper reforestation of submarginal forest land in southern Michigan.

An estate of over 2,000 acres at Brooksville, Fla., was presented to the Federal Government to be used in part for experimental work by the Department of Agriculture in cooperation with the Florida station in studies of citrus fruits, livestock, feed and forage production, and related problems.

Experiment fields provided for by the Kansas Legislature were established in the south-central part of the State, on three major soil types, primarily for studying the production of the staple crops of the region. Similar experiment fields were planned for the northeastern part of the State.

The Clemson College truck experiment station, a new substation, was established on a tract of 67 acres about 7 miles south of Charleston, S.C., and deeded to Charleston County for this purpose. Under the appropriation by the county for buildings and equipment a main office and laboratory building costing $5,000 was erected and a deep-well water supply with pressure system was installed at a cost of about $800.

A cooperative agreement was entered into by the Wisconsin station and the Department of Agriculture providing for the establishment and operation of a soil-erosion experiment farm. Under this agreement the State of Wisconsin furnishes a farm of 160 acres and the Department provides for its operation and for carrying on research. The farm, located near La Crosse, Wis., has a topography especially well adapted for measuring runoff and studying other phases of erosion and its prevention.

The Northeastern Forest Experiment Station was removed from Amherst, Mass., to New Haven, Conn., where close contact will be maintained with the Yale University Forestry School and the Connecticut State station.

A cottage for housing staff members was constructed at an approximate cost of $10,000 at the North Platte substation in Nebraska.

At the middle Tennessee substation an open barn 34 by 102 feet was completed for experimental work in feeding and breeding sheep.

A dairy barn for 35 head of cattle and with room for 100 tons of hay was completed at each of the Wyoming State farms at Afton and Lyman, which are under the direction of the Wyoming station.

ADJUSTMENTS TO MEET EMERGENCY CONDITIONS

Much attention was given during the year to revising research programs and projects and adjusting them to reduced financial support and to emergency needs. The utmost discrimination was exercised in selecting problems for investigation, with special reference to their application to the depressed economic situation; more effective cooperation of various research agencies in the study of major problems was developed; and substantial economies were effected.

A large number of stations were faced with actual or prospective cuts in financial support from State and local sources and at the same time with an increased demand for aid in dealing with acute economic problems. Reduction of financial support ranged all the way from 0.4 to 80 percent, necessitating in some cases drastic cuts in salaries and maintenance, with loss of seasoned and experienced staff members, abandonment of important investigations and useful service work, and curtailment of published output, but on the whole with more intensive work on major problems that were pressing for immediate attention.

Reports from experiment stations which may be considered fairly to represent conditions throughout the country show that among the steps taken to meet the emergency were: (1) Reducing personnel and salaries and refraining from filling vacancies or creating new positions; (2) reduc-

ing expenditures for buildings, equipment, and travel; (3) suspending outlying experimental work; (4) eliminating less essential projects and activities; (5) limiting work to the more urgent projects and those most likely to aid producers in reducing cost of production and improving market quality and price; (6) extending studies bearing on readjustment of farming systems to secure more efficient land utilization; (7) extending and intensifying work on problems in efficient marketing of farm products; (8) extending efforts to find new and better uses for farm products, waste products, and by-products; (9) giving increased attention to studies that furnish a sound basis for revision of rural tax systems and better use of tax receipts; and (10) increasing emphasis on the practical significance and application of results already achieved.

An experiment station in the far Northwest, adapting its program to a 17.5 percent reduction in income, reports:

> In considering the projects which could be continued, we have taken into account such elements as economic importance, number of people affected, comparative cost of investigations, the interest of cooperating parties, and other factors by which a piece of work may be measured.

The director of another station in the Northwest, the income of which had not been reduced, reports:

> Adjustments in some of our research programs are made from time to time to meet emergencies. This is true of the present emergency, especially with the program in farm management and agricultural economics. . . . Larger emphasis also is given to forage crops than heretofore in order that the areas in pasture and forage may be increased and the acreage in cereals reduced. . . . In spite of, or perhaps because of, the economic situation the pressure upon the station for information and for more work than is under way at the present time has not decreased. In fact, it is as great or greater than at any time.

A Pacific coast station, notwithstanding an increase in income of 11.3 percent, reduced expenditures for travel and equipment, eliminated less important projects, suspended some outlying experimental work, moderately reduced salaries, and put increased emphasis on economic studies, particularly those relating to efficiency of production and marketing.

An experiment station in the north-central United States, adjusting its research program to a 1.5 percent reduction in income, reports:

> All of the lines of work in the experiment station have shared approximately equally in the budget reductions, with the exception of agricultural economics, which is now receiving more financial aid than it did two years ago. We have been strengthening our program of cooperative marketing, and most of the increase in allotments to the department of agricultural economics has gone into marketing work. Because of the low prices for products farmers have to sell and the difficulty of securing cash, our whole research and extension program . . . is emphasizing a "grow your own" program in which we urge farmers to raise a larger portion of the feed for their livestock and of the products which the farm supplies towards the family living.

The director of a midwest experiment station, facing a 10.4 percent reduction of income, says:

> We have not materially changed the emphasis of our research program as a result of the present emergency except to allocate a somewhat larger percentage of our funds for the study of economic problems, especially those relating to taxation, marketing, and land use.

A central-western station, adapting its program to a 9.1 percent cut in allotment and decline in income from sales, reduced the staff somewhat; cut salaries and curtailed expenditures for labor, travel, printing, and equipment; and abandoned four experimental fields in different parts of the State. Increased emphasis is being put on—

> the problems of distribution of agricultural products; finding new uses for farm products other than for feed and foods; . . . and finding or developing new or unusual crops as possible substitutes for major farm crops now produced in excess of present requirements.

The director of another central-western experiment station, the income of which was reduced 18.4 percent, said:

> Emphasis is being placed upon the whole question of reducing costs of production by the introduction of new crops which seem to thrive on exhausted soils made infertile by continuous cropping, practiced by farmers as a result of the low prices of agricultural commodities and the enormous farm indebtedness.

Some minor projects and employees were dropped.

The director of a New England station, the income of which was reduced 14.9 percent, said: "A few projects have been dropped and others have been reorganized. Few, if any, new activities have been begun."

A liberally supported station in a northeastern State, to effect a saving of 5 percent in salaries and 10 percent in maintenance, made many changes in program to meet existing conditions, including particularly increased emphasis on studies of living cost, types of farming, regional readjustment of old farming methods to secure better land utilization, and rural government. Production problems which have sud-

denly become acute under the depressed economic conditions have also received special attention.

The director of an eastern station, the income of which was slightly increased, reports a considerable reduction in number of projects—

> retaining those that, in our judgment, are likely to be of particular value under present economic conditions and those in which continuity through a term of years is absolutely essential. No new projects will be initiated during the current fiscal year.

The director of another eastern station, anticipating a reduction of income, said: "We are endeavoring to concentrate our work on those problems which seem to have the greatest practical value to farmers and rural people in the State."

A southern station, which had to adjust its program to a 24.5 percent cut, reduced its staff, salaries (17 percent), and travel expenses; eliminated outlying field projects; restricted printing; and confined projects to those which promised to be most productive and immediately helpful in the present emergency and lent themselves to the most effective coordinated effort.

The director of a southeastern station, operating on a slightly increased income but anticipating a reduction, reports that salaries were reduced about 20 percent and practically all new projects were "planned and conducted with a view of securing information which might help to meet the present emergency." Increased emphasis was placed on economic investigations, although an effort was made to continue the important lines of research under way and to add others which seemed to be especially needed under the prevailing conditions.

An experiment station in the far South, to meet a 24.4 percent cut in income, reduced salaries, wages, travel, and expenditure for equipment, but made no change in research program except to undertake a study of the taxation system of the State, with the expectation that the results will aid in equalizing taxes.

Other stations report similar adjustments. A number of the stations voluntarily made readjustments and reductions in recognition of the financial situation or in anticipation of reductions in income.

COORDINATION AND COOPERATION

Progress in coordination in agricultural research by Federal and State agencies was evident during the year, especially in growth of the cooperative spirit, better organization and administration of cooperative projects, greater economy in the use of funds for research, and more efficient service. The mutually helpful relations between Federal and State agencies were maintained, and the advantages of well-considered and carefully planned cooperation were more fully recognized. This was true not only of institutions and agencies but of individual specialists, and recognizes the fact that many of the most important problems calling for investigation require for their complete solution the active cooperation of specialists in more than one line. The larger cooperative undertakings are a matter of formal agreement and record, but much of the most effective cooperation is a result of informal understandings between different specialists within the experiment stations and in other research agencies.

A total of 863 cooperative undertakings in agricultural research in which the Department of Agriculture and the experiment stations took part during the year was recorded in the Office of Experiment Stations. This was 124 or 12.5 percent fewer than during the previous year. This decrease in number of agreements may be attributed not to a declining interest in cooperation but to completion of several studies, consolidation of others in the interests of both service and economy, and a rather widespread curtailment of financial resources available for research.

All but one of the stations cooperated with bureaus of the Department during the year, the number of cooperative agreements per station ranging from 1 to 43. These agreements were distributed by subject as follows: Improvement of quality and lowering the cost of production of cereal, forage, textile, and other field crops and fruit and truck crops, improvement of pastures and ranges, and combating crop-plant diseases, 334, as compared with 374 the previous year; agricultural economics, farm management, and rural sociology, 143, as compared with 173; improvement of animal products (especially meats), combating animal diseases, and improving the breeding of animals, 92, as compared with 111; soils, soil surveys, improvement of soil fertility, and fertilizer development and improvement, 70, as compared with 96; combating insect pests of plants and animals, 74, as compared with 64; introducing greater efficiency into agricultural-production operations by adapting engineering principles, 68, as compared

with 76; improvement of dairy stock and products, 36, as compared with 40; improvement of timber crops, combating forest-tree insects, and forest maintenance, management, and reseeding, 29, as compared with 36; improvement of human foods and of food-management practices, 9, as compared with 11; maintenance of economically important wild life and combating animal pests, 5, as compared with 3; and studies of weather conditions important to agriculture, 3, as compared with 3 the previous year.

Lines of work in which cooperation between the stations and the Department was most extensive during the year included: Soil surveys, representing practically every major agricultural area in the country; prevention of soil erosion; improvement of irrigation practices; utilization and cost of farm power; use of concentrated fertilizers; fertilizer requirements of potatoes on different soil types; machine placing of fertilizers for cotton, corn, potatoes, and canning crops; improvement of corn and other cereals; breeding of improved varieties of potatoes resistant to disease; establishment of type varieties of vegetables; use of parasites to combat the oriental fruit moth; increasing the efficiency of oil sprays; plant-disease survey; relation of conformation and anatomy of the dairy cow to productive ability; use of proved sires in breeding for high milk and butterfat production; beefiness and milk production in dual-purpose cattle; quality and palatability of meat; the growth of wool; cure and prevention of contagious abortion of cattle; economic and sociological survey of the Appalachian highlands region; types of farming; cotton grades and market prices; livestock production, marketing, and meat utilization in areas released from cattle-tick quarantine; and establishment of a farm real estate tax index.

Cooperation between the stations and Department bureaus in agricultural research is thus being aimed at important specific regional and national problems and is coordinating to a high degree the efforts of the interested research agencies as well as the use of the best facilities available. For example, the work in the quality and palatability of meat coordinates research in animal production, human nutrition, and economics, both in the Department and in the stations concerned, and is typical of the cooperative research of regional or national character involving groups of stations.

RESEARCH PROJECTS AND PROGRAMS

Through such revision, readjustment, and coordination of research programs and projects as has been described, the experiment stations not only effected substantial economies in the use of funds, but were able to put increased emphasis on urgent economic problems of the farm and farm home.

Complete information on the total number of station projects active during the year as compared with the previous year is not available, but such information is available for all projects supported by the Adams and Purnell funds. Adams projects increased from 420 in 1931 to 436 in 1932, Purnell projects from 1,340 in 1931 to 1,458 in 1932. There was a wide variation in the number of projects supported by the Adams and Purnell funds at the different stations. In general, there appears to have been a tendency toward a larger number of projects with smaller individual allotments from these funds.

The Adams fund was used, as heretofore, mainly to support fundamental research having as its object more efficient production and improvement in quality and use of the product. Of the 436 Adams projects, 87, allotted $113,000 of Adams funds, dealt with investigations having as their object better control of plant diseases; 55, allotted $96,000, with maintenance of soil fertility and more efficient use of fertilizers; 54, allotted $55,000, with more effective control of insects and related subjects; 47, allotted $68,000, with a more scientific basis for plant and animal breeding; 46, allotted $103,000, with improvement of animal production; 41, allotted $71,000, with more effective control of diseases of livestock; 31, allotted $65,000, with improvement of horticultural practice and products; and 26, allotted $51,000 of Adams funds, with the physiological behavior of plants with reference to nutrition and growth. A limited number of Adams projects and a small proportion of Adams funds were devoted to investigations relating to home economics, but none to investigations in agricultural economics and rural sociology.

Of the 1,458 Purnell projects 348, involving an expenditure of $781,000, dealt with economic problems; 53, involving an expenditure of $113,000 of Purnell funds, with rural social conditions; and 145, calling for an expenditure of $273,000, with home economics problems. It thus appears that one third of the Purnell projects and

nearly one half of the Purnell fund were devoted to investigations in these three fields. The distribution of Purnell projects by other major objectives was as follows: Improving animal production, 205, with an allotment of $461,000 of Purnell funds; improving horticultural practice and products, 118, with $197,000; control of plant diseases, 103, with $133,000; control of insect and other pests, 96, with $145,000; improving culture and quality of field crops, 89, with $180,000; maintaining soil fertility and securing better use of fertilizers, 70, with $168,000; extending applications of engineering to farm and farm-home problems, 59, with $104,000; and control of diseases of livestock, 52, with an allotment of $98,000 of Purnell funds.

In effecting economies to meet reduced income there appears to have been a tendency, particularly in case of Purnell projects, to concentrate on those of more immediate importance or that might be completed in a relatively short time.

RESEARCH IN AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

Present conditions emphasize the importance of research designed to aid in solving the economic and welfare problems of rural people; they also demonstrate the advantage to be gained from concerted natural- and social-science attacks upon the problems of distribution and consumption as well as upon those of production.

The institutions of agricultural research and education in the United States have from the beginning kept constantly in mind three great objectives, namely: better farming, better business, and better rural life. Public recognition of the importance of these objectives and of the ability of science to aid in attaining them has come not all at once but gradually, and in the order named. With the expansion of agriculture in the United States and the increasing complexity of the problems which had to be met, it soon became evident that when farmers attempted to solve their own problems progress was too slow, and the need for publicly supported agencies for agricultural research was recognized and met.

Since the establishment of agricultural research agencies vast changes have come over agriculture and rural life. Before the World War farmers directed their main efforts to increasing production. Now a major objective is to sell what is grown at a satisfactory price. Then, there was a hunger for land. Now, land goes begging for buyers and the problem of what to do with surplus and submarginal lands in cultivation is serious. Then, markets from an ever-increasing and advancing world population were anticipated. Now, the effort is to adjust production to the realities of consumption. The rate of population increase has declined and consumers are less able to buy. The outstanding needs of agriculture today, therefore, are more efficient production, better prices for farm products, larger incomes, and improvement in the quality of rural life.

So intricately interwoven are the technical, economic, and welfare problems of agriculture that, in supplying dependable information, neither the natural nor the social sciences operating alone will suffice; but when united in a common purpose they constitute a most effectual force for rural alvancement. In the unity of the natural and social sciences lies the strength of agricultural research.

Natural-science research is frequently characterized as "production research", with the intimation that it is the cause of surpluses, low prices, and depressions. As a matter of record, American agriculture frequently experienced surpluses, low prices, and depressions before the establishment of institutions of agricultural research and education in the United States. We must, therefore, look beyond production research for the causes of agricultural depression and take into account growth of rural population, expansion of arable lands, increased facilities and incentives to production, unfounded optimism about prospective demand, and the lack of a feasible plan for adjusting production to consumption.

The natural sciences, by showing how to lower costs of production, maintain fundamental soil resources, prevent losses from diseases and pests, enhance the quality of farm products to better serve both producer and consumer, develop new uses for surplus products, and increase conveniences and lighten the physical burdens of farming and home making, have contributed immensely to the improvement of farm incomes and to the comforts and satisfactions of rural life. Some ways in which natural-science research continues to supply technical information of increasing value to agriculture and rural life are indicated on pages 10–47 of this report.

Farmers' appreciation of the fact that economics research might point the way to better farm incomes doubtless had its inception in the depression of the nineties. This awakened an interest in research in farm management, marketing, prices, land utilization, comparative advantage of one section over another in the production of specific products, taxation, finance, and foreign competition and demand. Rural people's appreciation of the fact that their welfare problems are susceptible of scientific study arose out of the report of the Country Life Commission appointed by President Theodore Roosevelt in 1908, and the greater part of its growth has come since the World War, particularly since the passage of the Purnell Act.

Rural people are rapidly coming to realize that they need, not only more of the necessities and comforts of life derived from better and more business-like farming, but also more of the things that minister to their intellectual, cultural, moral, and spiritual needs and that constitute the strength and fullness of both rural and urban life.

The knowledge required for improving rural life must come from scientific studies of both rural and urban population; rural-urban migrations and town-country relationships and advantages; relation of rural environment to the characteristics of the population; rural groups, organizations, and institutions; rural social psychology; and rural social pathology.

As American agriculture has advanced technically and territorially, its economic and social problems have become more pressing and complex. As rural people came to recognize the nature of these problems and their susceptibility to scientific study, the research agencies of the country found or developed specialists capable of finding the new types of information required for betterment of conditions.

Since the initiation of research in agricultural economics and rural life by the experiment stations, remarkable progress has been made in these fields. In last year's report on the agricultural experiment stations[2] attention was called to the fact that during the year ended June 30, 1931, approximately 48 percent of the Purnell fund was spent in support of research in agricultural economics, home economics, and rural life. Attention was also called to improvements in the qualifications of specialists, projects under way, available funds, importance of problems selected for study, growth of cooperation in research, methods employed, and published results.

During the year ended June 30, 1932, the number of active station projects in economics increased slightly, with only minor changes in supporting funds. In agricultural economics the number of active projects was 348, or an increase of 17 over the previous year. Of the total number, 24 projects were on costs of production, 124 on farm management, 143 on marketing and prices, 23 on taxation, 7 on credits, 6 on tenancy, 17 on land economics, and 4 on less specialized problems. The record indicates an increasing public interest in the study of problems pertaining to land utilization, adjustments in farm management, marketing, and related problems in the fields of rural taxation and agricultural finance.

Fifty-three station projects in rural sociology were active during the year, 17 more than in the previous year. Of these, 7 dealt with rural population, 10 with standards of living, 3 with rural institutions, 10 with farm organizations, 10 with communities, 5 with rural-urban relations, 2 with rural social psychological problems, 5 with rural social pathological problems, and 1 unclassified. In this field the major emphasis is on rural groups, organizations and institutions, and standards of living.

Obviously, the field of rural-life research is only partially developed. Considering the paucity of dependable information on rural-welfare problems, greater consideration might well be given to problems of rural population, rural-urban migrations and their social effects, and the relative noneconomic, human advantages of rural and urban areas. Rural welfare might also be advanced by giving more attention to the social obligations of farmers' organizations, and particularly to rural destitution in the present depression.

Considering the fact that rural-life research is in its formative stage of development, noteworthy progress is being made in this field. The specialists in rural life are making satisfactory progress in improving research methods; by a process of elimination they are selecting for study problems of distinctive importance to rural welfare; they are retaining their respective viewpoints and at the same time are cooperating with the natural-

[2] JARDINE, J. T., BEAL, W. H., and STEECE, H. M. STATION PROJECTS. U.S.Dept.Agr., Off. Expt. Stas., Rpt. Agr. Expt. Stas. 1931: 7. 1932.

science and economic groups. These specialists have exceptional opportunities to make helpful contributions to rural welfare and to aid in solving some of the more acute national problems.

B. YOUNGBLOOD.

SOME PRACTICAL BENEFITS OF RECENT EXPERIMENT STATION WORK

In a previous report[8] the cost and benefits of experiment station work were briefly discussed and attention was called to some outstanding achievements of the stations, classified by subject-matter divisions of research. In the following pages the subject is presented from the standpoint of recent contributions of the stations to the solution of certain major and more urgent practical problems of agriculture, home making, and rural life. Brief references are made to recent contributions by the State stations which illustrate the use made of public funds in the study of such problems as conserving and increasing soil fertility, introducing new and better crops and methods of farm management, reducing losses from plant and animal diseases and insect pests, improving methods of breeding and feeding animals, and otherwise reducing production cost; aiding marketing and increasing financial return by improving quality of product; finding profitable means of utilizing surpluses, waste products, and by-products; and aiding rural people to make better use of their resources in improving living conditions.

In assembling material for the review, the Office of Experiment Stations has had the assistance of experiment station directors as well as of various members of the office staff, the latter including: H. C. Waterman in soils and fertilizers, H. M. Steece in agronomy, J. W. Wellington in horticulture, Walter H. Evans in diseases of plants, W. A. Hooker in insect pests and animal diseases, George Haines and H. W. Marston in animal husbandry and dairying, R. W. Trullinger in agricultural engineering, F. G. Harden in agricultural economics and rural sociology, and Sybil L. Smith in home economics. The sources of material were current publications of the stations, direct communications from the station directors with permission to make free use of them, and first-hand examination of the work of the experiment stations by representatives of the office.

The review is necessarily briefer than those of previous years. It does not attempt to present a complete summary of significant accomplishments of the stations as a whole, nor of individual stations. It is hoped, however, that it will show that the stations are contributing effectively to the solution of many important practical problems of the farm and the farm home.

REDUCING COST AND INCREASING EFFICIENCY OF PRODUCTION

A primary object of experiment station research is to aid the farmer in producing at less cost a product that will command a better price. The stations are therefore giving much attention to improved methods of soil maintenance; better crop plants and methods of culture; more efficient methods of controlling insect pests and plant diseases; better methods of breeding, feeding, and management of farm animals; more effective control of animal diseases; better methods of farm management and of marketing farm products; and related subjects. They are dealing very thoroughly with such things as contribute to higher technical efficiency, better management of the farm business, and increased income.

MAINTAINING AND INCREASING SOIL FERTILITY

Maintenance of soil fertility.—Many of the stations are engaged in long-time field experiments to determine the fertilizer requirements of crops and soils and to discover how soil fertility may be maintained. Encouraging conclusions drawn from such long-time experiments as those of the Pennsylvania and Ohio stations are that the fertility of most soils may be indefinitely maintained and, further, that "the farmer now has it in his power very materially to increase the yield of the acre, and at the same time to reduce the unit cost of production."

Simple tests for soil fertility.—The need for methods of determining the fertility deficiencies and fertilizer needs of soils more simply and quickly than by chemical analysis and time-consuming and expensive field and pot experiments has led some of the stations to seek such methods.

Simple colorimetric methods devised by the Connecticut station make it possible to determine easily and quickly the acidity (pH value), the available

[8] JARDINE, J. T., BEAL, W. H., and STEECE, H. M. Op. cit., p. 3.

phosphoric acid, different forms of nitrogen, active (toxic) aluminum, and replaceable calcium in soils.

A simple, rapid, and dependable field and laboratory test for phosphorus requirements of soils, based on examination of the tissue of plants growing on the soils, has been devised by the Indiana station. The Virginia station has developed a method of testing the sap of corn which appears to give reliable indications of the nitrogen and potash needs of soil for the growth of corn.

Minor soil constituents.—It is now generally recognized that in addition to the so-called essential fertilizer constituents—nitrogen, phosphoric acid, potash, and lime—there are certain minor soil constituents, such as manganese, boron, copper, iodine, and others that play important parts in plant nutrition and in determining the quality of the crop, being, as a rule, beneficial or harmful according to the quantities present.

The Kentucky station, among others, has demonstrated that manganese, boron, copper, iodine, and other minor constituents are widely distributed in small quantities in rocks and soils and have important functions in the nutrition of both plants and animals. For example, this station has shown that lettuce grown without manganese is deficient in growth-promoting properties and that a small amount of boron is apparently essential to the normal growth of lettuce. The Virginia station finds that manganese and boron are necessary nutrients for the corn plant and that manganese, boron, copper, zinc, and arsenic in small amounts appear to increase the resistance of corn plants to frost. The Rhode Island station has found that plants growing on certain soils of that State are benefited to a marked extent by small applications of manganese salts. The Florida station has obtained highly beneficial results from the use of small applications of manganese, copper, and other substances on the reclaimed Everglades soils. The Indiana station found that a black silty loam apparently lacking in available manganese was improved by adding soluble manganese salts or by treatments that made the soil manganese more soluble. From investigations reported by the California station it appears that small amounts of manganese and boron are essential to the healthy growth of citrus trees.

Harmful effects have been observed in soils containing unusually large amounts of manganese. For example, the Arkansas station found that the yield of rice is decreased by the relatively large quantities of manganese in the rice soils of that State; the difficulty, however, is readily overcome by applying lime or other basic materials. Pineapples have been shown to develop chlorosis when grown on Hawaii and Guam soils containing excessive amounts of manganese, the trouble being easily remedied, however, by spraying with a solution of iron sulphate.

The harmful effect on certain crops of a deficiency of magnesium in the soil has been shown by several of the stations and by the Department of Agriculture (p. 15). For example, chlorosis, which seriously reduces yield and quality of corn and tobacco in the Connecticut Valley, is attributed by the Massachusetts station to magnesium deficiency. Harmful effects of a similar deficiency in the potato soils of Aroostook County have been reported by the Maine station. An effective remedy has been found in the use of magnesium-containing fertilizer salts or dolomitic (magnesian) limestone.

The prevalence in certain regions of goiter and goitrous troubles of man and beast has been associated with deficiency of iodine in the soils, waters, and plants of those regions. The matter has been investigated in several States, notably by the South Carolina station and other State agencies.

More effective use of fertilizers.—As a result of work done by the experiment stations and the Department of Agriculture, the use of high-grade and concentrated fertilizers has greatly increased, with gains in efficiency and savings in cost of transportation and handling. More efficient means of applying fertilizers have also resulted from such work. For example, the South Carolina station has shown that the common practice of applying fertilizers in contact with cotton and corn seed interferes with germination and growth of the seedling, and the study has indicated how the fertilizer should be applied to be most effective; the result is that manufacturers are now making fertilizer distributors which so place the fertilizer as to insure rapid germination and optimum growth. Similar results have been reported by other stations.

Continued use of ammonium sulphate has been shown to result in an acid condition and lowering of productiveness of certain soils unless lime or some other basic substance is used to correct the acidity. The West Virginia station, among others, has deter-

mined the conditions under which the sulphate is most effective as a fertilizer, thus extending the possibilities of profitable use as a fertilizer of this important industrial by-product (p. 15).

Soil erosion.—Erosion, particularly on lands devoted to row crops, has assumed such proportions as to make its prevention and control a problem of primary concern throughout the United States. A number of stations, many of them cooperating with the Department, are making an intensive study of ways and means of preventing the enormous losses due to this cause.

Terracing has been practiced and has been found very effective in controlling erosion. For example, the Oklahoma station, in cooperation with the Department, found that a loss of 43.9 tons of soil per acre occurred during 1931 from an unterraced area with about 6-percent slope planted to a cover crop of rye, followed by cowpeas and later by winter wheat, while from a similar terraced area planted to the same crops only 1.25 tons of soil per acre were lost. More than 35 times as much soil was eroded from the unterraced as from the terraced area. In addition to controlling erosion, terracing has been found to be effective in conserving moisture. The Oklahoma station obtained an increase of 33 percent in the yield of wheat on practically level land and under the dry conditions of the Panhandle as a result of terracing, the increase being attributed almost entirely to the conservation of moisture.

A method of strip cropping, consisting of planting strips of densely growing fibrous-rooted crops between strips of clean-tilled crops along the contours of eroded slopes, has been shown by the Alabama and Texas stations, the latter cooperating with the Department, to be highly effective in retarding the rate of run-off and increasing the spread and absorption of rain water. The Alabama station found that Cecil clay soils which eroded badly under cotton culture could be held in place by alternating strips of cotton and soybeans across the slopes. By this means erosion was reduced approximately 8 percent on a 5-percent slope, 50 percent on a 10-percent slope, and 52 percent on a 15-percent slope. The method, however, is not considered practical on this type of soil for slopes greater than 12 percent.

Measurement of snow cover.—The Nevada station has recently completed a long series of studies of snow cover in mountain regions as related to water supply for irrigation, power, and other purposes. From this study methods and apparatus which are in use practically everywhere that snowfall measurement is of economic interest have been developed. The Utah station, cooperating with the Department, has also developed improved equipment for measuring the extent and water content of snow cover and has established snow surveys in the principal watersheds of the State which furnish a basis for reliable water-supply forecasts.

More efficient use of irrigation water.—Accurate measurement and equitable distribution of irrigation water is a matter of great public concern in irrigated regions. Methods of measurement heretofore in common use have been inaccurate and wasteful. By long-continued observations and investigations the Colorado station, cooperating with the Department, has developed what is known as the Parshall measuring flume, which appears to excel all others in accuracy and dependability for both large and small canals and ditches and is rapidly replacing the ordinary rating flume, especially where the deposition of sand and silt is a serious problem.

From 25 years' investigation of supplemental irrigation in the Willamette Valley, where there is more than 500,000 acres of naturally drained arable soil well suited for irrigation of diversified crops and nearly an equal area fairly well suited for irrigation of pasture or forage crops, the Oregon station has found that small fruits and truck crops, crops grown for intensive dairying, and row crops making maximum growth late in the season respond profitably to supplemental irrigation. With water at a maximum price of $1 per acre-inch, an average application of 6.44 inches yielded a net gain of $8.80 per acre in profit from irrigation. The data indicate that it should pay to pump water from a depth of 25 to 40 feet for pasture, alfalfa, or clover, and from more than twice that depth for potatoes or berries. Crop rotation with manure in each rotation and with supplemental irrigation more than doubled the yield and profit per acre-inch of irrigation water and cut in two the cost of water per pound of dry matter produced.

Increasing the Efficiency of Crop Production

Crop production has been made more efficient and the quality and market value of the products have been

greatly improved by the work of the experiment stations and the Department of Agriculture in originating and introducing superior varieties and in furnishing a scientific basis for methods of culture, protection from insect pests and diseases, handling and marketing the product, and various other activities.

NEW AND IMPROVED VARIETIES

A great number of improved varieties and strains of field crops, fruits, nuts, vegetables, and ornamental plants originated or introduced by the stations and the Department have replaced with great advantage, both in yield and quality and return to the producer, inferior varieties previously grown. Many stations are taking an active part in such work.

As a result of 50 years' breeding and trial of fruits by the New York State station, no fewer than 176 varieties of fruits have been offered to growers for trial, many of them proving far superior to any previously grown. Long-continued efforts of the Minnesota station to develop good quality winter-hardy fruits adapted to Minnesota conditions have resulted in a number of such varieties which have come into general culture. The Latham and Chief raspberries (p. 14), the Haralson apple, and a number of hybrid plums originated by the station are now widely grown throughout the State and in other States.

Improved grains.—It is estimated that 70 percent of the wheat and barley acreage of California and 90 percent of the oat acreage are planted to varieties introduced and distributed by the California station, which means an added income to the grain growers of California of about $600,000 per year.

Of the 3,600,000 acres of wheat annually harvested in Montana, over 90 percent is planted to varieties recommended by the station. Of these, Montana 36, developed by the station, has practically displaced all others in the Gallatin Valley. Karmont, a superior variety of wheat originated by the Montana station and the Department, is also reported to be extensively grown in Montana. Yogo, a new winter wheat of promise developed by the Montana station and the Department, has recently been released for limited trial by Montana growers.

Examples of improved varieties of grain developed by the Minnesota station which are now being generally grown by farmers include Minturki, a winter wheat; Marquillo, a stem-rust-resistant spring wheat; Minrus, Anthony, and Gopher oats; and Velvet and Glabron barley.

Tenmarq, a variety of hard red winter wheat developed by the Kansas station in cooperation with the Department, has been distributed to growers with the expectation that it will prove superior to other varieties in regions adapted to it. Ceres wheat is an outstanding contribution of the North Dakota station now reported to be grown on 4,000,000 acres in the hard spring wheat belt. Gasta wheat, improved and introduced by the Georgia station, has shown ability to produce 15 percent more wheat per acre than the best commercial strains grown in the State.

The use of early-maturing varieties of oats developed by the West Virginia station is adding appreciably to the income of the farmers of that State. Gopher oats, introduced, tested, and distributed to farmers by the West Virginia station, is meeting with such favor that the demand for seed far exceeds the supply. Colorado 37, a variety of oats originated by the Colorado station, has proved superior to other oats in yield and has almost entirely replaced them in the irrigated sections of the State. Many other improved varieties of oats have been developed by the stations either independently or in cooperation with the Department.

Colsess barley, a variety originated by the Colorado station, is especially suited to the mountain districts of Colorado because it yields well and can be used either as grain feed or as hay. Of the 7,500,000 bushels of barley grown under irrigation in the State in 1932, about 35 percent is of this variety.

Some promising new varieties of rice developed by the Louisiana and California stations, cooperating with the Department, have recently been released. Among these are Fortuna, adapted to Louisiana conditions, and Colusa, suited to California conditions.

Cotton.—Arkansas Rowden 40, a variety of cotton developed and distributed by the Arkansas station, is widely grown in the State and has shown decided superiority over varieties previously grown. Oklahoma Triumph 44, developed by the Oklahoma station, has proved superior in both yield and quality to older varieties.

Potatoes.—Strains of Peachblow and Russet Burbank potatoes, developed by the Colorado station, are now being

used extensively in the San Luis Valley and appear to be superior to other strains for that district.

Soybeans.—The Pekwa soybean, developed by the West Virginia station, is rapidly coming into favor with farmers of the State. Because of the fineness of its stems and the ability to retain its leaves, the Pekwa variety is preferred for hay. Its yield of seed, however, compares favorably with that of the best varieties previously grown. Another selection of equal promise known as Kingwa, derived from the same source as Pekwa, has been shown by the Indiana station to be well adapted to southern Indiana.

Peaches.—A number of excellent varieties of peaches have been developed by the New Jersey station and some of them are extensively used by commercial growers. A plant patent for one has recently been secured.

Raspberries.—To the Latham raspberry, originated by the Minnesota station several years ago and now recognized as one of the best red raspberries, the same station has recently added a new variety, Chief, which possesses the same vigor as the Latham, with somewhat higher quality of fruit.

Strawberries.—A seedling strawberry, the McClintock, originated and recently released to growers by the Tennessee station, has shown marked superiority over other commercial varieties such as the Klondike and Aroma in uniformity of size and in quality throughout a long season. The Corvallis strawberry, originated, developed, and introduced by the Oregon station, has proven more productive, better flavored, and firmer than varieties commonly used for canning, and is coming into use by growers.

Cabbage.—Failure of cabbage to make marketable uniform heads has been a cause of great loss to cabbage growers. By inbreeding and crossing methods the New York Cornell station has found it possible to secure a uniformity of heading hitherto unknown and has produced extremely promising inbred selections and crosses. Seed of these improved strains are being produced in sufficient quantity to make a thorough practical test. This will benefit an industry with an annual production of over a million tons. New York alone produced 469,200 tons in 1930. A variety of cabbage known as Penn State Ballhead, developed by the Pennsylvania station, has proven superior in uniformity and yield to commercial strains of Danish Ballhead and appears to be rapidly replacing them among commercial growers.

Sweet corn.—Several varieties of sweet corn adapted to southern conditions have been developed by the Texas station by transferring the sugary kernel character of northern sweet corn to the common Texas field corns, thus adding sweetness without otherwise affecting the productiveness and adaptability of the field corn. By using these varieties sweet corn can be put on the northern market considerably in advance of the varieties commonly grown, thus greatly extending the green sweet corn consumption period.

Onions.—The Early Grano onion, developed by the New Mexico station from a Spanish variety, has proven well adapted to culture under irrigation in New Mexico. It is a rather early, sweet Spanish onion, somewhat smaller than the regular Valencia and not quite so good a type, but it matures about 3 to 5 weeks earlier than the old Valencia onion, is of excellent quality, seems to keep well, and sells well on the market. Directions for growing the onion and producing seed have been published by the New Mexico station. A new strain of the Valencia onion having outstanding merit and value to the State has been developed by the Colorado station.

Canning peas.—A new early sweet canning pea of superior quality, developed by the Wisconsin station, has recently been released to growers. Progress is also reported by the New York State station in developing strains of peas resistant to root rot, frequently the limiting factor in pea production in the State, reducing both the yield and the quality of the peas.

Squash.—The Buttercup squash is a superior variety, especially suited to North Dakota conditions, developed through selective breeding by the North Dakota station. The Kitchenette and New Brighton squashes are two superior varieties introduced by the Minnesota station and accepted by growers.

IMPROVEMENTS IN CULTURE

Cotton.—Certain cotton soils of the South are becoming unproductive because arsenic has accumulated in them as a result of long-continued use of calcium arsenate to combat the boll weevil. The trouble appears to be progressive and likely to become increasingly harmful with continued use of arsenical insecticides. The South Carolina station, however, has found

that the affected soils can apparently be restored to their normal productivity by the simple and inexpensive method of applying iron sulphate, which fixes the arsenic in the soil and neutralizes its effect on the cotton.

As already explained (p. 11), continued use of ammonium sulphate on certain kinds of soils without suitable correctives results in an acid condition which reduces productivity. The Alabama station finds, however that on limed soils ammonium sulphate is as efficient as sodium nitrate for cotton. The Georgia station finds that the use of limestone with cotton fertilizers containing sulphate of ammonia is profitable.

The liberal use of potash fertilizers, alone or in combination with nitrogen fertilizers, the Arkansas station finds, is not only effective in controlling wilt and reducing injury from rust but stimulates growth and increases yields of cotton.

Machinery for harvesting cotton has been used to a limited extent in the more recently developed cotton-growing regions of the Southwest. In those areas the growth usually is not as rank and the crop matures more uniformly than in most parts of the Cotton Belt. The Texas station has developed a tractor-operated harvester of the stripper type which will gather over 90 percent of the total crop. Using this and similar strippers, the cost of harvesting, cleaning, and ginning a bale of cotton in northwest Texas was found to be about $14, as compared with $26 for hand snapping. The general use of such a machine, under conditions to which it is adapted, would greatly reduce the cost of cotton production.

Potatoes.—It is well known that potatoes grown in acid soils are less subject to scab than those grown in alkaline soils. The New York Cornell station, however, found that if the soils are allowed to become excessively acid the yield is reduced. Long Island growers have obtained the best yield of marketable potatoes when the soil was kept just sufficiently acid to guard against serious losses from scab. In no case should even the most acid soils be limed at a greater rate than with 500 to 600 pounds of hydrated lime per acre.

The production of seed potatoes has been intensively studied by many experiment stations, both with regard to freedom from disease and quality of the tubers. In experiments with Triumph potatoes on dry land, the Nebraska station obtained maximum yields of scab-free and marketable tubers by planting June 15–20. The Ohio station found tubers from May plantings to be the best for planting the following spring. The maximum vigor of sprouts was observed about 11 months after the crop was planted the previous year.

Nearly 70,000 tons of fertilizer are used each year on potatoes in eastern Virginia. The Virginia truck experiment station and the Department, cooperating with growers, have demonstrated the advantage of using a well-balanced complete fertilizer for potatoes. A 6–6–4 (N–P–K) ratio has proved most suitable for fine sandy loams and an 8–6–6 ratio for sandy loams in this region. Nitrogen appeared to be more important than phosphorus or potassium in the fertilizer. The higher nitrogen fertilizers were especially effective in years of heavy spring rainfall.

A potato sickness observed in Maine potato fields in 1929 was found by the Maine station to be due apparently to deficiency of available magnesium in the soil (p. 11). The difficulty was overcome by applying magnesium in some readily available form. In some commercial fields the application of magnesium oxide resulted in an increase of as much as 40 barrels of potatoes per acre. Using 200 pounds of magnesium sulphate per acre at a cost of $3.50 was found to be effective.

Sweetpotatoes.—The South Carolina station in cooperation with the Department has shown that tobacco barns can easily be adapted for curing and storing sweetpotatoes during the period when the barns are not needed for tobacco, thus effecting a considerable saving, with the added advantage that a barn in which tobacco has been previously cured during the current season is disinfected sufficiently for storing sweetpotatoes.

Soybeans.—The soybean has rapidly become one of the most important annual legume crops in the United States, as shown by the fact that its acreage increased from 190,000 in 1920 to 3,190,000 in 1929, with a great increase in its agricultural and industrial uses. The Ohio station found that the soybean grows comparatively well on acid soils and those of low fertility and is drought-resistant if well established before dry weather sets in.

The alleged harmful effects of soybeans on succeeding crops has been investigated by a number of experiment

stations. The West Virginia station found that whether the yield of wheat following soybeans is increased or decreased depends upon the interval between the soybean harvest and the seeding of the wheat. Good yields were obtained with wheat seeded 4 to 6 weeks after the soybeans were harvested, but the reverse was true of wheat seeded 3 days after the soybean harvest. The apparent explanation of the difference was found in the nitrate content of the soils. This was lowest at the time of soybean harvest. It increased rapidly after harvest, and within a month the supply was ample for the vigorous growth of wheat. The station therefore concludes that early harvest of soybeans or the application of some nitrogen fertilizer is essential to good yields of wheat as a following crop, since by these means an ample supply of available nitrogen for the young wheat plants is assured. With corn, however, the late harvesting of soybeans is preferable, since it insures high nitrate content during late spring and summer, when the need of the corn crop is greatest.

Sugar beets.—The California station has shown that early-planted sugar beets, especially those sown in late December, January, and early February, make better growth and are more resistant to curly-top infection than are late-planted beets. The crops from early plantings were characterized by good yields and higher sugar percentages, and had very few or no bolters, i.e., beets sending out seed stalks prematurely.

Tobacco.—Investigations by the Connecticut station have been far-reaching in their beneficial effect on tobacco growing in the Connecticut Valley. The station has developed new and improved strains and better methods of fertilizing, harvesting, and curing, and in many other ways has helped to put tobacco growing in the valley on a more efficient basis. It has shown that potash increases resistance to drought and possibly to certain kinds of diseases, makes the cured leaves soft and more suitable for handling, and improves the burning quality of cigars made from the tobacco. Various potassium salts as well as tobacco stems and cotton-hull ashes have been shown to be satisfactory sources of potash for tobacco.

Improvement of pasture lands.—There are large areas of relatively unproductive pasture lands in the United States. Of the total farm land of Massachusetts, for example, 753,000 acres, or 37 percent, was classed as pasture in 1929. Much of this is stony upland pasture badly run down and yielding only sparse pasturage. As a result of many years' study, the Massachusetts station found that such pasture lands can be made to produce a fair return by an average investment of $5 to $10 per acre in lime and complete fertilizer. The following treatment or its equivalent is recommended: 1 ton of ground limestone (or its equivalent in hydrated lime) every 6 years, 480 pounds of 16 percent superphosphate and 160 pounds of muriate of potash every 3 years, and 160 pounds of nitrate of soda annually. This recommendation probably has wide application, because similar unproductive pastures are found in many other parts of the country. The West Virginia station has shown how superphosphate and lime may be profitably used to restore the declining productivity of the extensive pasture lands of that State.

Curing of hay.—Satisfactory field curing of hay is difficult, especially in hot, humid climates. Several methods and machines for artificial curing have been developed (p. 33), but the high first cost of equipment and the expense of operation prevent the average individual farmer from using them. The Mississippi, California, and Illinois stations have found that crushing the hay plant increases the rapidity of drying. The Mississippi station has found it possible, by a proper combination of cutting, crushing, swathing, and windrowing, to make well-cured, highly nutritious Johnson-grass hay practically within the limits of a working day and with considerable saving of labor as compared with usual practices. A combination mower and crushing device as a tractor attachment was developed for use in this process.

Clover failures.—The decline of red clover growing in many farming areas has been ascribed to "clover sickness." The Kentucky station, among others, found that use of foreign and unadapted seed was largely responsible for the failures. The consequent recommendation that locally grown seed be used has been of great benefit to clover growers.

Orchard irrigation and cultivation.—Establishment by the California station of the fact that plants require soil moisture only slightly above the permanent wilting point and that in the absence of weeds cultivation has little or no effect in reducing evaporation from the soil, has made possible a large reduction in the cost of fruit production.

Improved nursery stock.—A system of removing variants and undersized citrus seedlings in the seed bed and nursery, proposed by the California station and voluntarily adopted by nurserymen, it is believed will insure larger and more productive trees in the orchard. Similar work has been done by the New York State station with apples, which showed strong correlation between after-budding size and size of 1- and 2-year-old apple trees, and between 1- and 2-year-old trees; but insignificant correlation between planting size and after-budding size, between planting size and size of 2-year-old trees, and between planting size and size of 1-year-old whips.

Misnamed fruit trees.—Misnamed fruit trees have always constituted a serious problem for the orchardist, particularly the grower of slow-maturing trees such as the apple and pear. Years of painstaking and costly care are lost if the trees, on fruiting, turn out to be of some inferior or unprofitable variety. The Massachusetts station has developed a technic by which trees may be identified while still in the nursery rows. Among characters used in identification are color of the bark, angle of the branches, and folding, thickness, and serration of the leaves. These characteristics were found to be as reliable and constant as are the fruit characters upon which identification has so long been based. The new technic has proved so reliable that it has been accepted by fruit growers and nurserymen and sponsored by the Massachusetts Fruit Growers Association as a most important step in solving the troublesome problem of misnamed trees.

Pruning.—Pruning fruit trees has been the subject of great differences of opinion and practice. The Illinois station found that severe winter injury follows heavy pruning of apples and that "initial bearing is delayed, size of the tree is reduced, the crop is thinned, and profitable production postponed when young apple trees are pruned moderately to heavy." The New York Cornell station, however, considers it desirable "to do as much pruning on 2-year-old apple trees at planting time as is necessary to correct existing framework weaknesses." The West Virginia station has found that "light pruning of apples, peaches, plums, and cherries for the first few years after planting produces larger trees which come into bearing earlier than trees more heavily pruned." The California station has shown that young citrus trees will come into full bearing a year or more sooner and yield larger crops if they are pruned considerably less than has been the common orchard practice. The same station also found that pruning of grapes is weakening in proportion to its intensity and has suggested much-needed modifications that have resulted in largely increased profits to the growers.

Poor set of cherries during cloudy weather has been found by the Wisconsin station to be due to faulty nutrition resulting from deficiency of sunlight, indicating that cherry trees should be pruned so as to be relatively open-topped to admit the maximum amount of sunlight.

Ringing of fruit trees.—Ringing of fruit trees is an old practice, the practical value of which is a matter of difference of opinion. As a result of experiments and observations over a number of years, the Pennsylvania station advises apple growers to ring filler trees but not permanent trees. Stayman Winesap and McIntosh apple trees ringed in early June of their seventh year yielded 4 bushels of apples per tree in the eighth year, while the untreated trees yielded less than 1 bushel.

Thinning of apples.—The practical value of thinning apples has been investigated by several stations. The Ohio station found that on Grimes Golden apples 10-inch thinning gave the best results as measured by size and total weight of fruit. Eight-inch thinning gave the most satisfactory results with Jonathan.

Orchard heating.—In southern California approximately 70,000 acres of citrus groves producing a crop with an estimated annual value of more than $50,000,000 are provided with 3,500,000 sheet-iron orchard heaters and smudge pots valued at about $5,000,000, which burn low-grade fuel oil as an orchard protection to the crop on frosty nights. At times these devices have caused such serious smoke nuisances as to result in threatened legislative action against their use. Because of the great economic importance of continuing this protection of citrus orchards against frost as cheaply as possible, the California station investigated the possibility of burning ordinary grades of fuel oil in simple inexpensive heaters without producing visible amounts of smoke at normal burning rates. It was found that the smokiness of many types of heaters can be reduced by proper regulation and cleaning and that the composition of commercial fuel oils

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has no consistent influence on the smokiness of different heaters. Manufacturers have made use of this information in designing less smoky and more effective heaters.

Pollination of fruits.—Most fruits have been found incapable of producing full crops with their own pollen, and certain kinds produce no fruit at all unless cross-pollinated. In the mixed-variety orchard the pollination problem is automatically solved, but in commercial orchards where 1 or 2 varieties dominate, the situation becomes acute. For example, in the Bitterroot Valley of Montana specialization in McIntosh apples was followed by decreased yields. The Montana station found that including Delicious, Jonathan, and certain other varieties decidedly increased the yield of McIntosh. Again, in the Champlain Valley of New York, McIntosh specialization resulted in decreased yields, but the New York Cornell station found that Fameuse, Delicious, and Cortland interplants were effective in stimulating the yield.

Self-fertile varieties of apples and those that are sterile when not supplied with suitable pollen, as well as varieties which are good pollen producers, have been identified by the South Carolina station. On the basis of this information many of the old orchards of the State are being interplanted and topworked with varieties which are good pollinizers, and in this way unproductive orchards are being made productive.

The sweet cherry is another fruit in which pollination is a problem. The leading varieties of the Pacific Northwest, namely, Bing, Lambert, and Napoleon, have proved to be not only self-unfruitful but intersterile. The Washington station found that Deacon, a good market cherry similar to Bing in size, color, and shape, is an effective pollinizer for all three. Obviously the savings to growers from the use of such knowledge must run into a large sum. The solution, namely, interplanting, is simple, easy, and relatively inexpensive to put into practical operation.

Storing apples.—Storing apples at prevailing temperatures for a month after harvesting and then reducing the temperature to 32° F., the Massachusetts station found, results in a great saving in refrigeration costs without loss of efficiency. Experiments reported by the New Hampshire station indicated that holding McIntosh apples 5 days after picking, at 65°, and then promptly cooling them when stored, reduced brown core and improved the flavor.

Propagation of blueberries.—An inexpensive method of propagating blueberries, which reduces the cost of cuttings to one third or less, has been developed by the Washington station. Since there are large areas in western Washington and western Oregon where blueberries may be grown to advantage, the possibility of producing blueberry plants at one third or less of the former cost is likely to prove a deciding factor in the development of the blueberry industry on the west coast.

Reducing labor costs of harvesting and preparing vegetables for the market.—Labor costs of harvesting and preparing asparagus, beets, and carrots for the market under ordinary methods have been found by the Massachusetts station to amount to 50 percent of the cost of production. The station has worked out in detail methods that greatly reduce the labor cost.

Premature seed formation in vegetables.—For many years vegetable growers have suffered severe losses from the premature formation of seed stalks in various vegetables such as beets, cabbage, celery, and lettuce. The New York Cornell station found that low temperature in the early stages of growth is conducive to seed-stalk formation, while moderately high temperatures tend to cause vegetative development. A simple solution of the difficulty was found to be the growing of young vegetable plants in a greenhouse or protected frame until outdoor temperatures have risen sufficiently to warrant transplanting into coldframes or field. The general acceptance of the finding would save thousands of dollars for growers.

Fertilizers versus manure for truck crops.—The scarcity and high price of manure, the Illinois station found, need not seriously interfere with the production of such crops as spinach, lettuce, beets, peas, beans, tomatoes, peppers, carrots, potatoes, and cauliflower, since commercial fertilizers are capable of replacing the manure to a large extent. The station found that "when half the manure was replaced by commercial fertilizers even higher yields resulted than when the greater quantity of manure was used," and that with most of the crops "comparable yields were secured when the entire amount of manure was replaced by commercial fertilizers." When no manure was used complete fertilizers gave higher yields than incomplete fertilizers.

Cutting asparagus.—The yield and quality of asparagus depends to a large extent on the spacing of the plants and the length and intensity of the cutting season. The California station found that plants spaced about 18 inches apart in rows 7½ feet apart gave the best results. The average weight of spears per plant and the yield of spears per acre increased from year to year during the seven cutting seasons. The same station has also shown that shortening the cutting season improves the grades and quality of asparagus, and as a result the old long cutting seasons have been abandoned.

Onion sets.—Onion sets one half to three fourths inch in diameter produced onions of better quality and yield than did larger or smaller sets, in experiments reported by the Massachusetts station.

Fertilizers for tomatoes.—In experiments to determine the most efficient use of fertilizers for tomatoes, the Michigan station found that on sandy loam and clay loam soils the use of fertilizers applied in the hill greatly hastened maturity and thus increased profits by making it possible to market the fruit while the price was high and by lessening the amount of fruit left on the vine at the end of the season. The applications found most effective were 500 pounds per acre of a fertilizer containing 4 percent of nitrogen, 16 percent of phosphoric acid, and 8 percent of potash on the sandy loam soil, and the same amount of fertilizer containing 16 percent of phosphoric acid and 8 to 16 percent of potash, on the clay loam soil. The Kentucky station has worked out ratios of nitrogen, phosphoric acid, and potash in fertilizers for tomatoes. These ratios result in high yields and provide a basis for fertilizer recommendations which may have far-reaching value in growing truck and perhaps other crops.

Many important improvements in the culture of ornamental plants have resulted from the work of the experiment stations and the Department. The following are a few examples.

A possible new method of greenhouse culture.—As a result of long-continued plant-nutrition investigations by the New Jersey station, a method of growing carnations, roses, and other ornamentals in sand with a constantly renewed nutritive solution has been tried on a commercial scale and appears to have certain distinct advantages over ordinary commercial methods of production.

Effect of length of day.—It has been well established by the Department and some of the experiment stations that the length of day, or photoperiod, has a profound influence on the growth and blooming of certain species of plants. The practical applications of this knowledge are now being studied by a number of stations. The New York Cornell station has forced chrysanthemums into bloom from 39 to 57 days earlier than normal by shading the plants with black cloth for 2 hours at each end of the day. The results indicate a possible inexpensive means of controlling blossoming which may be profitably used, particularly in forcing blooms for holidays and other special occasions.

Forcing flowering plants with artificial light.—The fact that "light is one of the great limiting factors in forcing flowering plants in the greenhouse during the winter, particularly where long-day crops are concerned", led the Ohio station to make a series of tests with different kinds of flowering plants, using 75- to 100-watt clear-glass lamps from 6 p.m. to 10 p.m. during the winter. By this means earlier production and resultant higher prices were obtained at small cost with Calceolaria, Cineraria, Spanish iris, *Centaurea cyanus*, *C. imperialis*, Scabiosa, Didiscus, Schizanthus, feverfew, annual chrysanthemum, Salpiglossis, Coreopsis, Gaillardia, Shasta daisy, and pansy. In experiments made by the Illinois station, "flowering of gladiolus corms was doubled and trebled under artificial lighting, the results depending upon the variety, the intensity of the light, and the stage of development of the plants when the lights were first turned on". The Rhode Island station found that blossoming of gladiolus grown in the winter in greenhouses can be increased 80 percent by an additional 5 hours of artificial light from a 1,000-watt nitrogen bulb.

Flower pots.—In tests of paper flowerpots, the Massachusetts station found that if the pots are properly impregnated with some substance, such as asphalt, that prevents decomposition, they may be used successfully for growing plants. If, however, as the Massachusetts and South Carolina stations have shown, the pots decompose, they furnish food for micro-organisms which make use of the nitrogen of the soil and cause nitrogen starvation of the plants, unless available nitrogen in excess of the needs of the micro-or-

ganisms is supplied to the soil. Similar experiments with like results have been reported by the Pennsylvania and Iowa stations. The Massachusetts station also found that the tin-can plant container, so commonly used, is not only cheap but very efficient and appears to have certain distinct advantages, for limited use, over paper and other kinds of containers.

Weed control.—Efficient herbicides and cultural methods of weed control which are in extensive practical use have resulted from work of the experiment stations.

Ammonium thiocyanate, a by-product of coke ovens, has been found by the Minnesota station to be an efficient weed killer. Its use is free from fire hazard or danger of explosion. It is cheaper than many other weed-destroying chemicals and also has some fertilizing value. The New York Cornell station has found sodium chlorate to be effective in eradicating deep-rooted perennial weeds such as wild chicory when applied in the fall before the ground freezes.

Puncture vine (*Tribulus terrestris*) is one of the most harmful weeds in California, causing enormous losses and rendering large areas of valuable land almost worthless. The California station found that the weed can be effectively controlled with oil sprays at a great saving over methods previously used. The station has also developed an effective and easily prepared arsenical herbicide for perennial weeds.

The most efficient means of eradicating Canada thistle, the Ohio station found, is to mow them just before bloom and then to spray after some regrowth has occurred, applying first 2 to 3 pounds of sodium chlorate per square rod and following this by further spraying the next season.

PROTECTION AGAINST INSECT PESTS

Breeding insect-resistant plants.—To aid in the struggle with insect pests that are responsible for enormous losses by the farmer, the experiment stations are turning with encouraging results to breeding crop plants resistant or tolerant to insect attack.

The Kansas and Nebraska stations report definite progress toward the production of hard red winter wheats that resist the Hessian fly and appear to be as good as other improved winter wheats.

The Illinois and Ohio stations, cooperating with the Department, are developing short-season strains of corn that appear to have value in combating the European corn borer. The Michigan station also reports encouraging progress in developing a strain of corn that is of good marketable quality and is resistant to the European corn borer. The Virginia station, cooperating with the Department, is developing strains of corn with a husk that completely covers the ear and affords protection against injury from the corn ear worm, an insect which annually destroys from 2 to 10 percent of the corn crop of the State.

The Kentucky station, observing that certain varieties of clover and alfalfa are more resistant to leaf-hopper attack than are others, is attempting, with promise of success, to find the cause of this difference and use it as a basis for developing resistant strains. Other examples of progress along this line might be cited, all tending to encourage the hope that effective aids in combating insect pests may thus be developed.

Examples of effective use of artificial methods of control—spraying, dusting, and the like—might be multiplied almost indefinitely. A few, recently reported, are cited to show the character of such work.

Beet leaf hopper.—In cooperation with the Department, the Utah station has made a study of the beet leaf hopper; the study furnishes a basis for more effective control of this destructive insect and carrier of curly top.

In further experiments with fluorine compounds as insecticides, the Tennessee station found such compounds highly satisfactory as a means of controlling the flea beetle on tobacco.

Pea aphids.—An easily constructed and operated chain drag designed by the Kansas station has been found a very effective means of destroying pea aphids, one of the most serious enemies of alfalfa.

Grasshoppers.—Airplanes have been used successfully in dusting cotton, forest trees, alfalfa, and other crops, and in scattering poison bait for control of grasshoppers. About 200,000 pounds of poison bran mash prepared by Iowa station formulas was distributed in this way. The planes distributed the bait very evenly and without danger of poisoning farm animals.

Tar-distillate sprays.—Tar-distillate sprays made from commercial by-products have been used successfully by the New York State station in the control of various insect pests, particularly the black cherry aphis and the oyster-

shell scale, two insects which heretofore have been especially difficult to control on a commercial scale.

Insecticide carriers and stickers.—The effectiveness of insecticides depends largely on the tenacity with which they adhere to the sprayed plants. Solid waxes emulsified with triethanolamine oleate have been found by the New Jersey station to be efficient carriers of insecticides and to possess appreciable toxicity as contact insecticides. When impregnated with either pyrethrum or derris extract, emulsions containing 1 percent wax were found to be highly toxic to both sucking and chewing insects.

Stationary spray outfits.—Spraying orchards is a costly operation, until recently done largely with portable sprayers differing in size, price, and cost of operation and maintenance. Use of the portable sprayer requires considerable labor and is limited to fairly level lands. The Georgia, Illinois, Indiana, Maryland, New Jersey, Ohio, Washington, and West Virginia stations have developed the utility and economy of the stationary spray plant for large orchards, with the result that such equipment is now in rather wide practical use. It has the great advantage of being adaptable to use in orchards where portable sprayers could be used only with the greatest difficulty or not at all. The West Virginia station has found that for large orchards the initial cost of the stationary system need be no greater than that of complete portable equipment. In addition, the stationary equipment saves time, labor, and material, and enables prompt spraying when needed, even in wet weather, according to the experience of the Georgia station.

Apple maggot or fruit fly.—More effective means of controlling the apple maggot or fruit fly, considered one of the most serious enemies of apples, blueberries, and other fruits, have been reported by the Maine, Massachusetts, and Wisconsin stations.

Pistol casebearer.—A combination of nicotine sulphate and penetrol has been shown by the West Virginia station to be an effective spray material for control of the pistol casebearer, which has been causing great losses to apple growers in that State in recent years. In response to an appeal from the orchardists, the station was able to respond in a comparatively short time with a satisfactory remedy.

Cherry curculio.—The Colorado station developed methods shown to be effective in controlling a new cherry curculio, which has been causing large losses to cherry growers.

Cherry fruit fly.—The cherry fruit fly, which has been causing a loss estimated at one fourth of the cherry crop of Oregon, worth approximately $300,000 annually, is being effectively controlled by methods proposed by the Oregon station.

Citrus mealybug parasites.—The importation and establishment of two Australian parasites (*Coccophagus gurneyi* and *Tetracnemus pretiosus*) of the citrus mealybug by the California station in 1928 has prevented the recurrence of infestations which it is estimated were costing the citrus growers of Orange County, Calif., alone, $500,000 to $1,000,000 annually.

Plum tree borer.—A simple, cheap, and effective means of controlling the plum tree borer, consists of painting the bark of the trunk and larger limbs of plum trees with a solution of paradichlorobenzene (1 pound) dissolved in melted paraffin (4 pounds) or in cottonseed oil (1 quart). The method has been discovered by the South Dakota station.

Blackberry mite.—The control of blackberry mite, which has caused losses of from 10 to 90 percent of the crop at ripening time in Oregon, has been made possible by methods developed by the Oregon station, with a possible saving to growers of $100,000 annually.

Tree cricket on raspberries.—The raspberry industry in California, now estimated to have a value of $739,000 annually, was threatened with extinction by the tree cricket (*Oecanthus niveus*). An effective method of controlling the insect at a cost of about $8 per acre, was developed by the California station.

Few of the numerous pests which enormously reduce the yield and impair the quality of truck crops, have escaped the attention of the experiment stations or the Department, and effective means of control have been found for many of them. A few examples from the great number which might be cited are given here.

Two-spotted mite.—The 2-spotted mite, which at one time menaced the asparagus fern industry in Florida, has, as a result of investigations made by the Florida station, been so reduced that it no longer interferes seriously with the production of the crop.

Harlequin bug.—The harlequin bug causes great damage to early truck crops in the South. The North Caro-

lina station has found and put into practical use a cheap and simple soap mixture which effectively controls this insect.

Celery leaf tier.—The celery leaf tier (*Phlyctaenia rubigalis*) is a major celery insect pest in Florida and in seasons of high temperatures causes serious damage to the celery crop. The Florida station found that fresh pyrethrum dust, either alone or mixed with lime or sulphur, applied with a traction duster on dry plants on calm days during the immature larval stage of the insect, gives effective control.

Red spider.—The red spider is a very troublesome orchard and greenhouse pest. The Massachusetts station has found miscible oils which effectively control red mites in the orchard. It has also found that the use of naphthalene as a fumigant is a satisfactory method for controlling the red spider in the greenhouse.

PROTECTION AGAINST PLANT DISEASES

Diseases of crops not only increase the cost of production but impair the quality of the product. The experiment stations are making notable contributions to their control through cultural methods, application of dusts and sprays, and also through the development of resistant varieties.

Breeding disease-resistant crops.—Breeding of resistant or immune varieties has proven to be an effective means of helping to control plant diseases. There are numerous examples of resistant strains and varieties of field crops developed by the experiment stations and the Department of Agriculture, which are now being used with advantage by growers. A few examples recently reported are referred to hereafter.

A number of bunt-resistant lines of hard red winter wheat have been developed by the Nebraska station. Selections of Burt oats that are highly resistant to stem rust have also been established by this station. Many of these selections are characterized by high yield and other desirable qualities and promise to greatly reduce disease hazards.

Peatland barley, a variety originated by the Minnesota station, is resistant to stem rust and appears also to be resistant to scab diseases which are causing discouraging losses.

The general use of Ridit and Albit, smut-resistant varieties of wheat developed by the Washington station, has greatly reduced loss from smut. Over 12,000,000 bushels, or approximately one half of the winter wheat crop of Washington in 1931, was of these varieties.

Wilt-resistant strains of cotton are now available to growers as a result of investigations by the Department and several of the experiment stations, including the Arkansas station among others, and their use by cotton growers is reducing the losses from this destructive disease.

Black shank of tobacco became so prevalent in west Florida as to threaten the entire shade-grown cigar-wrapper tobacco industry of that district, valued at approximately $1,800,000 annually. The Florida station has, however, succeeded in producing resistant strains (nos. 94 and 301) which are being grown commercially with satisfactory results not only in resistance but in yield and quality of the tobacco produced. A strain of burley tobacco resistant to root rot, which has caused large losses to growers, has been developed by the Kentucky station and appears to be giving good results in practice.

General use of yellows-resistant strains of cabbage, originated by the Wisconsin station, has saved an industry which otherwise was threatened with virtual extinction in some sections because of the ravages of the disease. Cooperating with the Department, the station has continued to develop improved strains of yellows-resistant cabbage especially adapted to different conditions and uses. Similar work has been reported recently by the Iowa station.

Jersey or Thousand Headed kale is the main crop grown for green feed in the Petaluma poultry-raising district of California. Spread of kale yellows made it impossible for many growers to produce sufficient kale for their needs. The California station has developed a strain of kale that is highly resistant to the disease, and poultry raisers are growing it with very satisfactory results.

Mildew Resistant cantaloupe no. 50, resulting from 5 years' work by the California station and the Department, has proven superior in yield to other varieties commonly grown, and is credited with saving the melon industry of the Imperial Valley, estimated to have an annual value of $10,000,000, which was threatened by mildew.

A strain of the Golden Self Blanching type of celery of superior market quality and extremely resistant, if not immune, to Fusarium wilt has been developed by the Michigan station.

Danger of loss from wilt in peas has been greatly reduced by extension of the use of wilt-resistant strains of canning peas originated by the Wisconsin station. This station has also developed and released to growers a mosaic-resistant canning bean, which promises to greatly reduce losses from this disease.

Fusarium wilt is one of the most destructive diseases of peas and is causing large losses to pea growers. The use of resistant varieties appears to be the only sure means of control. Progress has been made by several of the stations and the Department in developing resistant varieties. The Washington station finds, however, that general sanitation, crop rotation, and seed sterilization are necessary to reduce losses from the disease.

The loss from nematode injury of beans is widespread and serious in the South. It is believed that the Alabama station's discovery of two nematode-resistant pole snap beans which give high yields and compare favorably in quality with such standard sorts as Kentucky Wonder and McCaslan will do much to reduce losses caused by nematodes.

The following are a few of the many examples of station work in developing other effective means of controlling plant diseases.

Cotton root rot.—Continuing investigations on cotton root rot, the Texas station, cooperating with the Department, has found that susceptible and nonsusceptible plants may be identified simply by determining whether the fungus which causes the disease will grow in the juices of the plants. In general, cereals, grasses, and other monocotyledonous plants have been shown to be nonsusceptible, and a basis has thus been provided for rotations which aid in controlling the disease.

Potato diseases.—The widespread and destructive virus diseases of potatoes have been intensively studied by many of the experiment stations and the Department, with the result that effective methods of control have been developed and are now in general use with great advantage, especially to commercial growers of seed potatoes. The Montana station was among the first to work out such methods and to secure their use by growers. Use of the disease-control methods has already resulted in improvement of the market and price for seed potatoes as compared with common table stock.

Deterioration of seed potatoes cut 3 to 4 weeks before planting can be prevented and the yield of potatoes increased by dusting the cut seed with a sulphur-lime mixture at the rate of 6 to 7 ounces per bushel, the New York State station found.

The cost of spraying for late potato blight may be greatly reduced, the Maine station found, by delaying spraying until there is some evidence of blight. This would usually eliminate three early treatments and save Maine potato growers $300,000 annually on materials alone.

Sweetpotato diseases.—Sweetpotato growers in North Carolina have sustained heavy losses as a result of wilt or stem rot, scurf, and other diseases. The experiment station has shown that wilt can be controlled by treatment of the draws with Bordeaux mixture at a cost of less than 16 cents per acre, and that scurf, a storage disease which seriously affects the market value of the potatoes, can be controlled by dusting the roots with sulphur, at a cost of less than 25 cents per acre.

Bunt of wheat.—Dusting seed wheat with copper carbonate to control bunt, as recommended by the California and other experiment stations, has proved effective in eliminating bunt of wheat in California and elsewhere. By use of the method the average smut content of California wheat has been reduced from 2 percent to 1 percent.

Tobacco diseases.—Wildfire of tobacco, the Pennsylvania station found, can in large measure be controlled by sanitary precautions, beginning the year before field planting; such precautions include thorough sterilization of the seed-bed soil and equipment and great care to prevent infection. The proper procedure is explained in detail in a recent bulletin of the station. Relatively simple sanitary precautions have been found by other stations to be effective in controlling certain tobacco diseases. For example, the North Carolina station finds that tobacco mosaic, which reduces the value of North Carolina tobacco more than $1,000,000 annually, can to a large extent be prevented by the use of simple sanitary measures in the plant bed and in the field, and procedures easily followed in practice have been worked out by the station. The Kentucky station has succeeded in preventing the appearance, in the early part of the season, of mosaic, which causes widespread and large losses to tobacco growers. One preventive measure consists in not allowing workmen to use barn-cured chewing tobacco while pulling and setting plants.

Sugarcane root rot.—Much is known about fungus diseases of plants, but little is known about fungus enemies of fungus diseases. Special interest, therefore, attaches to the discovery by the Louisiana station of a fungus (Actinomycete) which not only robs the sugarcane root-rot organism (*Pythium arrhenomanes*) of nourishment, but produces a poison that kills it, and may therefore have value in controlling the root-rot disease.

Curly top of sugar beets.—Curly top is one of the greatest obstacles to the culture of sugar beets. The California station found that by early planting (December to February) to avoid leaf hoppers, which are carriers of the disease, danger from this source can be reduced. As a result, early planting is becoming an established practice with beet growers in California.

Cold injury.—Frost injury causes large losses. A simple, reliable, quick method of determining winter hardiness has an immense advantage, in saving of time and loss, over the usual method of field tests of the growing plants. Artificial freezing methods which in large measure meet this requirement have been devised by the Kansas, Minnesota, Nebraska, and Wisconsin stations among others. These accomplish in a short time what might require many years and might involve disappointment and loss if ordinary methods were followed. The applicability of such a method to alfalfa and other plants has been demonstrated by the Wisconsin station. The station found that "hardiness in alfalfa is . . . an adjustment of the plant to the fall environment; i.e., some varieties, such as the Grimm, 'harden up' or prepare for the winter, while tender kinds like the Peruvian do not have this ability to build up cold resistance in the fall." Using similar methods, the Nebraska station has found a few alfalfas relatively resistant to cold and wilt, and seed of the more promising sorts is being increased for distribution to alfalfa growers.

Crown gall.—An improved method of root grafting which is being used successfully to prevent crown gall and excessive callus-growth formation on apple trees was proposed by the Iowa station.

Fire blight.—A zinc chloride-hydrochloric acid-alcohol mixture has been found by the Ohio station to be a very effective and valuable aid in eradicating the fire-blight bacteria in the cankers.

Apple rust.—The red cedar is a carrier of apple rust, and one means of controlling the disease is to destroy red cedars in the vicinity of apple orchards. The red cedar is an ornamental and useful tree, and there has been much opposition to its wholesale destruction. The West Virginia station has found and is propagating rust-resistant types of cedars which it is thought will make its destruction unnecessary.

Cranberry false blossom.—The cranberry false-blossom disease has in recent years developed into a threat to the cranberry industry. The Massachusetts station found, however, that it can be controlled by power dusting with a pyrethrum-dust mixture.

Strawberry crimp.—The Florida station found that crimp, also known as dwarf, a bud disease particularly injurious to strawberries in Florida, can be controlled by use of relatively simple sanitary methods, including the setting of plants from nematode-free sources, weeding out and destruction of infected plants, renewing plantings yearly, and installing proper drainage facilities to prevent flooding and washing.

Pecan rosette.—Pecan rosette, the Arizona station reports, can be controlled by injecting zinc salts into the trees. New growths at the ends of previously affected shoots was normal on the zinc-treated trees, whereas that on similarly affected shoots on untreated check trees continued to show the characteristic rosette symptoms, usually in increasing severity as the season progressed.

Wilt of chili peppers.—The New Mexico station found that wilt, which has caused large losses in growing chili peppers under irrigation, can be greatly reduced through the simple, practical method of planting the peppers deeply on ridges, thus reducing the temperature, moisture, and chance for the fungus to come in contact with the plant through capillary rise of water in the soil.

Tomato diseases.—Damping-off of tomatoes, a very destructive disease, can be effectively controlled by dusting the seed with copper sulphate monohydrate, the New York State station found. The cause of collar rot, a destructive disease of tomatoes, has been determined by the Colorado station, and means of combating it have been found. Two new varieties of wilt-resistant greenhouse tomatoes, Blair Forcing and Lloyd Forcing, developed by the Illinois station, have been in-

troduced into the seed trade. The whole subject of control of tomato diseases is discussed in detail in a circular bulletin of the Michigan station, prepared especially for the use of home gardeners and commercial growers of tomatoes as a truck, canning, and greenhouse crop.

Diseases of asters.—Two diseases of the China-aster (yellows and wilt) are reported by the Wisconsin station to be seriously menacing the culture of this flower. Yellows is a virus disease transmitted by leaf hoppers. Wilt is caused by a parasitic fungus which may be carried on the seed and when once introduced persists indefinitely in the soil, making it "aster-sick." Yellows may be controlled by protecting the plants from leaf hoppers. The use of wilt-resistant strains appears to be the most promising means of reducing injury from wilt. Several wilt-resistant strains which appear to be of commercial value have been developed by the Wisconsin station. These have been widely tested on aster-sick soils with good results.

Bulb diseases.—Diseases which would practically prevent the establishment of a successful bulb-growing industry in Oregon are being controlled by the general use by growers of practices based upon investigations made by the Oregon station in cooperation with the Department.

Damping-off in the greenhouse.—As a practical means of sterilizing greenhouse soils to prevent damping-off of seedling plants, the Massachusetts station found acetic and undistilled pyroligneous acids as effective as formaldehyde and cheaper.

Instant Bordeaux mixture.—The fruit growers of West Virginia are benefiting materially from a simplified method of preparing instant Bordeaux mixture devised by the West Virginia station. As the name indicates, instant Bordeaux mixture is prepared by a quick method, using ingredients that go into solution almost immediately. Advantages lie in the elimination of special mixing equipment, the saving of time, and the uniformly high quality of the product obtained.

More Efficient Animal Production and Dairying

Reducing the cost and improving the quality in livestock and dairy production has been promoted in many ways by the work of the experiment stations and the Department of Agriculture, especially in furnishing a scientific basis for better methods of breeding, feeding, and management, control of animal diseases, and handling the products. The West Virginia station reports that farm practice in livestock production in that State is responding rapidly to the findings of the station. For example, there has been a striking increase in the use of purebred rams as a result of demonstration by the station of the superiority of market lambs derived from mating native ewes with purebred rams of standard breeds. Demonstration of increased profits to be obtained from supplemental grain feeding in finishing beef cattle and from marketing younger animals has also had a beneficial effect on production practices which are now in a stage of rapid transition toward higher quality and greater profits. Other examples of recent station contributions to improvement in livestock and dairy production follow.

Feeding, Breeding, and Management

Ranch management. — Ranch-management studies to determine efficiency of production on different ranches have been carried on with great benefit to ranchmen by the Wyoming station cooperating with the Colorado station and the Department. A model contract, for use when owners of feeder cattle go into partnership with owners of the feed for fattening them, has been worked out and published by the Wyoming station and has been received with favor by ranchmen.

Wheat as feed.—The low price of wheat has turned attention sharply to its use to replace more expensive feeds. The Colorado, Idaho, Illinois, Kentucky, Missouri, Montana, Nebraska, and Ohio stations have recently reported experiments which indicate clearly the limitations and possibilities of such use. In general these experiments have indicated that when prices of corn and wheat are about equal, wheat may advantageously be substituted for corn in rations for steers, cows, and hogs, if not fed in excessive amounts. There appears to be some advantage in grinding or cracking the wheat if the cost of doing so is not prohibitive. Apparently wheat does not give as uniformly good results with lambs as with other kinds of livestock. The hog appears to be the most efficient utilizer of wheat as feed.

For fattening cattle and calves, the Illinois station found that substituting

ground wheat for one half of the corn ration resulted in more rapid gains, lower cost of gains, a higher selling price, and more profits. The Montana station found coarsely ground wheat to be a safe feed for fattening cattle if not used in excessive amounts. A simple ration of wheat and alfalfa gave good results with calves. In experiments with yearling steers of good quality, the Missouri station found that ground wheat and cottonseed cake produced less rapid but more economical gains than do shelled corn and cottonseed cake. However, cattle that were fed shelled corn sold at higher prices. Yearling steers that were fed rations containing wheat made better gains and showed higher finish than those fed corn rations, in experiments reported by the Kentucky station. Wheat fed to cattle with cottonseed cake, alfalfa hay, and wet beet pulp showed a tendency to produce growth rather than finish, in experiments reported by the Colorado station. For dairy cows, wheat to the extent of 50 percent of the grain mixture, fed with alfalfa hay and corn silage over periods of 75 days each, gave as good results in milk production as did a good grain mixture containing no wheat, in experiments reported by the Ohio station. Cracked wheat proved practically equal to corn in rations for fattening cattle and hogs, in experiments reported by the Nebraska station.

Cottonseed meal as feed.—Cottonseed meal is a nutritious by-product feed which, however, has proven injurious to livestock under certain conditions. The problem of using it to the best advantage has been investigated by many experiment stations and the Department. Among the stations recently reporting such investigations are those of Florida, Louisiana, Michigan, Mississippi, North Carolina, New Mexico, Ohio, Oklahoma, Pennsylvania, South Carolina, and Texas.

The Michigan station found that as much as 9 pounds of cottonseed meal per animal per day may be fed to dairy cows with profit and without bad effect. The New Mexico station found that cottonseed cake, used as a winter supplemental feed for cows and weaned calves, was more palatable and uniformly eaten and produced greater gains than ground yellow corn. The Pennsylvania station reports injury to yearling heifers from heavy feeding of cottonseed meal, but that this may be corrected or prevented by feeding the meal with a small quantity of high-quality hay, carrots, or cod-liver oil. The North Carolina station reports that pork, softened by feeding peanuts, may be hardened by feeding a ration containing cottonseed meal. Harmful effects on the quality of eggs from feeding cottonseed meal to laying hens has been reported by a number of stations, including those of Louisiana, New Mexico, Oklahoma, and South Carolina. The South Carolina station found also that feeding cottonseed meal slightly reduces the hatchability of eggs. It found, however, that the meal is an efficient source of protein for egg production and when fed with skim milk may with advantage take the place of more expensive standard rations.

Raising draft horses.—Several of the experiment stations have attempted to find ways of reducing the cost of growing draft animals for the farm. In experiments reported by the Missouri station, colts fed a limited amount of grain and good roughage with bluegrass pasture from weaning time until they were 3 years old proved to be just as efficient work horses as were those fed nearly twice as much grain and roughage ad libitum, although they did not maintain so high a condition of flesh. The Michigan station also found that colts on a limited grain ration made as satisfactory gains in weight and skeletal development as did those on a liberal grain ration, and that there was a saving of about one third in feed cost per day.

Pregnancy and sterility in mares.—The value of reliable means of early diagnosis of pregnancy, especially in the case of valuable brood mares, is obvious. The California station has perfected a blood test by means of which a diagnosis of pregnancy in the mare can be made with a very high degree of accuracy at the forty-fifth day after service. Many horse breeders are obtaining satisfactory results with methods of control and prevention of sterility in mares as worked out by the Kentucky station.

Artificially dried hay as feed.—In view of the growing interest in artificial curing of hay a number of stations have undertaken to determine the feeding value of the artificially cured product. Artificially dried young grass has been shown by the Vermont station to have a very high feeding value, making it possible to substitute the dried grass for part or all of the grain in dairy rations. From 10 to 12 pounds of artificially dried grass per day was fed advantageously. (See also p. 33.)

Roughage for fattening cattle.—The discovery by the Kansas station that

silage plus a small amount of calcium in the form of finely ground limestone is just as satisfactory as the roughage portion of rations for fattening young cattle as is silage plus alfalfa hay, makes possible a material expansion of the cattle-feeding areas of the country, and is of particular value to farmers of the Middle West and Southwest because it shows that a satisfactory cattle-fattening ration may be made available wherever a silage crop can be produced and grain grown or purchased at reasonable prices. It indicates that the common belief that a legume hay is necessary in the fattening ration is not well founded.

Grinding feed.—The economic value of grinding feed has been investigated by a number of experiment stations. In experiments with pigs and dairy cattle, recently reported by the Wisconsin station, coarsely ground grain gave better results than that finely ground. The station concludes that "farmers do not need to grind corn for hogs on dry lot. It may pay to grind old corn for hogs on pasture, but medium-to-coarse grinding is more desirable than fine grinding." In experiments with dairy cows, chopped soybean hay proved to be about 11 percent more efficient than whole soybean hay. There was little or no advantage in chopping alfalfa hay for beef cows, dairy cows, and suckling calves, nor in chopping timothy hay for work horses. Grinding shock corn was found by the Ohio station to increase the beef returns per acre, but the cost of grinding lowered the financial returns. Similar corn, fed as silage, made the largest return per acre. Ground alfalfa hay proved no more valuable for cattle than unground hay, but showed a higher value for lambs, in experiments reported by the Arizona station.

Dairy-farm labor.—The very large labor demand of dairy farms is strikingly brought out in a recent report of the Wisconsin station. The station found that—

> the equivalent of two men is required to operate the usual Wisconsin dairy farm, consisting of about 80 acres in crops and 15 to 20 cows. The farmer and his family do approximately three fourths of the work—the other fourth is done by hired labor. Stated another way, 6,048 hours of man labor are required to operate the farm, of which 3,361 hours, or one half, are performed by the farm operator; 1,381 hours, or one fourth, by other members of the farm family; and the remainder, 1,306 hours, by hired labor.

The need for greater use of labor-saving machinery on dairy farms is indicated.

Best age for first calving of heifers.—From several years' study of the calving age of heifers, the Missouri station concludes that—

> the most efficient milk and fat production (utilization of nutrients) will be obtained by breeding animals to calve at from 20 to 24 months of age, maximum production at about 30 months of age, and within 5 to 10 percent of the maximum production at from 23 to 28 months, depending upon the breed.

Sheep breeding.—Regularity of breeding is important with sheep as with all other kinds of livestock. Failure of ewes to conceive delays the time when lambs are produced, and subsequent service makes an undue strain on rams if only a limited number are available. In studies dealing especially with the duration of the heat periods and the interval between them as related to certainty of conception, the California and Missouri stations found conception to occur more regularly in ewes bred more than 14 hours after the heat period began, indicating the importance of avoiding breeding during the early part of the period.

Mineral supplements.—It has been established that mineral supplements to feeding rations are not only beneficial but necessary in some cases. Harmful effects from mineral deficiency in the feed have frequently been observed. For example, a serious nutritional trouble of dairy cattle in Minnesota has been found by the experiment station to be due to a shortage of phosphorus in the roughage feed resulting from a low level of available phosphorus in the soil. The deficiency results in decreased milk production and inefficient use of feed. The station's recommendation that bone meal be used as a supplement to ordinary rations has been adopted with good results by a large proportion of the farmers maintaining livestock in the affected area. Salt-sick, anemia, and goitrous troubles, referred to on page 29 are other examples of the harmful effects of mineral deficiency in feeds.

It appears from investigations recently reported by a number of experiment stations that under certain conditions the use of mineral supplements may prove harmful or at least unnecessary. For example, the Oklahoma and North Carolina stations report that adding mineral supplements to rations already high in mineral matter reduces the rate and economy of gain in pigs, and the Illinois station concludes that when swine rations do lack minerals the minerals can, under

all ordinary conditions, be supplied by adding, singly or in combination, relatively cheap minerals such as salt, bone meal, and limestone.

Cows fed timothy hay, corn silage, and a good grain ration with fresh grass in season, the Vermont station found, completed their gestation and lactation periods with a positive balance of calcium and phosphorus without the use of mineral supplements (steamed bone meal and ground limestone). There were negative balances in the mineral constituents during the early part of the lactation period, but rapid storage of the mineral constituents took place as the lactation and gestation periods progressed. Similar observations have recently been reported by the California station.

Excessive amounts of bone meal or of oyster shell in the ration, the Texas station found, causes chicks to consume less feed and therefore to make less satisfactory gains than when more moderate amounts are used. Excessive amounts of bone meal in a ration for chicks in battery brooders was found to cause leg disorders as well as poor gains. The results indicated that when no meat or bone scrap or similar feed is given, 1 pound of oyster shell and 1 pound of bone meal to 100 pounds of feed are probably the proper amounts to use.

The use of mineral matter (bone meal, calcium carbonate, and the like) in addition to that supplied by protein concentrates rich in inorganic salts, was found by the Pennsylvania station to produce hock disease (slipped tendon) in poultry, a trouble that is causing poultrymen considerable concern. Similar conclusions have been reached by other stations.

Use of rock phosphate containing fluorine as a mineral supplement in the feed of dairy cows, pigs, and poultry has been shown by the Wisconsin station, among others, to result in a marked deterioration of bones and teeth.

Alfalfa as an exclusive feed.—Where alfalfa is abundant and green feed scarce and costly, the extent to which alfalfa can be used as an exclusive feed is of great economic importance. The Wyoming station has shown that comparatively heavy-producing cows of the Holstein-Friesian and Guernsey breeds can be maintained through the first and second lactation periods in a moderately high state of production without any apparent physical deterioration when fed alfalfa hay in winter and pasture in summer without any grain supplement after they are 1 year old. The station concludes that when grain is cheap as compared with alfalfa hay it may be profitably fed, but no damage to the cows will be done if the high price of grain makes its feeding unprofitable. Similar results have been reported by the Nevada station. On the other hand, the Oregon station did not get such favorable results from the exclusive use of alfalfa.

Green soybeans for hogs.—The growing of soybeans has rapidly increased in the United States, and many experiment stations have undertaken to find profitable uses for the crop. The South Carolina station has found the soybean valuable as a hogging-down crop. The maximum feed value per acre and a good quality of meat was produced when the hogs were turned into the soybeans before they had begun to fruit. Grazing mature soybeans, however, resulted in the production of soft pork, with a reduction in price which more than offset the lower cost of production.

Sex identification in young chicks.—A reliable means of identifying sex in young chicks has long been needed in the poultry industry. Such a method, based on differences in development of wing and tail feathers at hatching, is reported by the Kansas station. The experimental results indicate that the method may be used with a high degree of accuracy for the identification of sex in pure Rhode Island Reds and other pure breeds, both light and heavy, and that the characteristic feathering is present in both pure strains and crosses.

Breeding for egg production.—As a basis for improving breeding stock for egg production some simple and reliable method of recording the number and weight of eggs produced is necessary. The New Jersey station found that laying pullets can be reliably classified with regard both to number and weight of eggs by trap nesting for the 4 months succeeding October 1 and weighing all the eggs produced in January.

Fish oil and fish waste for poultry.—The discovery by the California station that sardine oil can be substituted for cod-liver oil as a source of vitamin D in poultry feeding is resulting in an estimated saving of $180,000 annually to the poultry industry of the State and at the same time has brought an additional revenue annually of more than $125,000 to producers of the oil. Like benefits from practical use of re-

sults of the station's experiments on fish meal as a poultry feed appear to be possible. Similar results with sardine oil and fish meal have been reported by the Washington station.

The waste fish of the Atlantic coast fishing industry has heretofore been utilized mainly as a fertilizer. The Maine station has recently reported experiments which show that fish properly dried and prepared may be used to increase the efficiency of poultry rations and to reduce the amount of expensive cod-liver oil required, thus furnishing to poultrymen an economical source of protein and opening a new market for this by-product.

Free-choice feeding of poultry.—Self-feeding of poultry has been suggested as a means of saving time and labor, but the Ohio station found that pullets fed an all-mash ration laid more eggs than did similar pullets on a free-choice ration. The birds on the free-choice ration consumed a larger proportion of grain to mash than did those on the all-mash ration. In experiments by the Delaware station, birds fed a mixed mash ate more feed and laid more eggs than did birds allowed to select their own feed. The self-fed birds did not balance their ration well, mortality was high, and under this method of feeding molting slow, and average egg weight low as compared with results from feeding a mixed mash.

An improved strain of bees.—A strain of Caucasian bees, developed by the Wyoming station in cooperation with the Department, has been found better suited to honey production in the Rocky Mountain region than are strains of Italian bees. The honey production of the Caucasian strain was 71 percent greater than that of the Italian strain during a 5-year period.

CONTROL OF ANIMAL DISEASES AND DISORDERS

Losses from animal diseases have been greatly reduced by work of the experiment stations and the Department of Agriculture. Means of reducing losses from such destructive diseases of animals as infectious abortion in cattle, pullorum disease of fowls, and others have been found. The following are a few examples of such work recently reported by the stations.

Salt-sick.—As already pointed out (p. 27), mineral deficiency in the feed is a frequent cause of serious troubles. For example, salt-sick, said to be the greatest single cause of loss to the cattle industry in Florida, has been found by the Florida station to be due to a deficiency of iron and copper in the feed of cattle in certain parts of the State. A simple and effective preventive, suggested by the station and now in practical use, is to give the cattle access to a mixture of 100 pounds of common salt, 25 pounds of red oxide of iron, and 1 pound of finely ground copper sulphate.

Anemia of pigs.—Anemia in young pigs, especially those not having access to pasture, is causing large losses where pork production is a leading industry. The Illinois, Indiana, Kansas, New York Cornell, and Wisconsin experiment stations have shown that anemia may be prevented by brushing the sow's udder with a solution of copper and iron salts, or in other ways inducing the young pigs to consume small amounts of these salts. Pigs having access to pasture apparently pick up enough of the minerals to prevent the disease. The solution recommended by the Illinois station is 0.7 ounce of hydrated copper sulphate and 4.5 ounces of hydrated ferric sulphate in 1 quart of water. The Indiana station reports that anemia may be prevented by the very simple expedient of putting the sow and pigs on clean sod within a week after farrowing or by placing good sod in the pigpens.

Goitrous troubles. — Various goitrous troubles of livestock have been found to be due to a deficiency of iodine in the feed. The Iowa station found that such troubles in lambs may be prevented by feeding as little as one twentieth of a grain of potassium iodine daily to the pregnant mothers.

Preventive and curative serums and vaccines, developed by the experiment stations and the Department, have been the means of preventing enormous losses from diseases of livestock, and advances are constantly being made in this line of research.

Sore mouth of sheep and goats.—The widespread use of a vaccine for sore mouth of sheep and goats, discovered by the Texas station, is proving of immense value to ranchmen of southwest Texas, where the disease has caused heavy losses.

Fowl pox.—Vaccines and methods of vaccination for the control of fowl pox have been developed and successfully applied by a number of experiment stations, including among others those of New Hampshire, Ohio, Oregon, Virginia, and Washington.

Poultry typhoid.—An effective vaccine for the control of poultry typhoid which threatened the poultry industry of North Carolina has been developed by the North Carolina station.

Infectious bronchitis (laryngotracheitis) of fowls.—The New Jersey station has perfected a method of artificial infection of the cloaca of fowls with a virus suspension which has proved to be highly effective in immunizing 3- to 4-months-old fowls against this disease.

Disease of horses.—An epidemic disease known as meningoencephalitis has been responsible for the loss of many valuable horses in California, Nevada, and Oregon. The Nevada station has succeeded in preparing a serum which arrests the disease, if it has not proceeded too far, and cures the affected animals.

Infectious abortion.—It is estimated that infectious abortion causes a loss to the American farmer of more than $50,000,000 annually as a result of reduced milk flow, loss of calves, and temporary and permanent sterility. It is now possible, however, through methods of detecting and isolating reactors, developed largely by the experiment stations and the Department, to establish and maintain abortion-free dairy herds and to put into effect efficient State-wide control that reduces these losses.

A high plane of nutrition, as compared with a lower-protein ration supplemented with common salt, had no effect in developing resistance to abortion infection, in experiments reported by the Wisconsin station.

To eradicate abortion from a herd of swine the California station found it necessary to test for reactors as often as every 2 weeks and to separate reactors completely from the rest of the herd.

Pullorum disease of poultry.—Advances in perfecting methods of control of pullorum disease of fowls were reported by several experiment stations during the year. For example, the Kansas station, among others, has found that spread of infection from diseased to healthy chicks in the incubator can be materially reduced by fumigating with formaldehyde and maintaining high humidity during the hatch. Incubator companies are now furnishing purchasers of their machines with practical directions for fumigation. The Massachusetts station has shown that pullorum disease may be transmitted by feeding eggs of reacting hens. A new method of eliminating the disease from farm flocks has been worked out by the North Carolina station, which has been active in producing chicks free from this disease and in devising means of preventing its spread. The Minnesota station cooperating with the State Livestock Sanitary Board and the United States Department of Agriculture has been active in developing a plan for State-wide testing for the disease.

Cannibalism in chickens.—Cannibalism in chickens, a vicious habit of picking toes, combs, vents, feathers, and other parts of the body where blood shows, has increased until it is recognized as one of the most serious problems in poultry production. The Washington station shows in a recent bulletin that it may be prevented by the use of a 100-watt natural ruby Mazda bulb in the fattening rooms or by spraying the windows with a rich red lacquer. It is stated that the second method gives as good results as the first and is somewhat cheaper.

Udder infections.—Udder infections such as mastitis constitute one of the most important difficulties in the production of high-grade sanitary milk. The New York State station has developed certain laboratory procedures which quickly detect mastitis with reasonable accuracy. The station has found the strip-cup and bromthymol-blue test of value for quickly detecting active mastitis infection. The Kentucky station has also found the bromthymol-blue test of value for the same purpose.

Improvement in Farm Structures and Equipment

In no line of experiment station work has there been greater advance in recent years than in agricultural engineering, and none exceeds it in number of possible advantageous contacts and cooperative relations with other lines of station work. Following are a few examples of recent station research in engineering applying especially to the improvement of farm structures and the more efficient use of farm implements and machinery (pp. 15 and 16).

Dairy buildings.—Dairy-building plans prepared by the California station, meeting the approval of the California Dairy Council and various health authorities of the State, have been put into use by farmers with an estimated saving of from $100,000 to $150,000 annually, not taking into account indirect benefits from better

management, health of herds, saving of labor, and improved quality of products.

The trench silo.—Silage is considered one of the cheapest and best forms of home-grown roughage for both beef and dairy cattle, but the initial cost of constructing ordinary silos is so large as to be almost prohibitive to many small farmers. Filling also calls for special machinery and considerable labor, which adds materially to the cost. The trench silo has been found a satisfactory and much more economical structure for the storage and curing of silage, by the Alabama, Colorado, Georgia, Mississippi, Nebraska, New Mexico, North Dakota, and South Carolina stations. Very little, if any, cash outlay is required to build such a silo during seasons when men and work animals are idle on the farm. The Alabama station has found that the cost of constructing a 50-ton trench silo need not exceed from $20 to $25. The greatest expense is in the machinery for cutting the silage. An inexpensive cutter has been devised by the Alabama station. The Colorado station has developed a type of trench silo which it has used successfully for storage of corn, sorghums, sunflowers, surplus potatoes, and other crops, and has published detailed directions for its construction and use. Colorado farmers are reported to be building such silos with little cash outlay and using them with satisfactory results.

Rammed earth as a building material.—Rammed earth (pise de terre), according to the California and South Dakota stations, appears to have certain advantages as a farm building material. Buildings constructed of this material are cool in summer, warm in winter, and less subject to condensation of moisture on the walls than are insulated farm structures.

Solar water heater.—Water heating for dairy and house use is an item of appreciable expense. The Alabama and California stations have found that where there is abundant sunshine the solar heater is a practical means of supplementing the hot-water supply. The Alabama station has found it possible to store from 58 to 84 percent of the available solar energy under favorable conditions and has developed a heater that can be built and installed for approximately $55. Solar water-heating equipment for both humid and dry climates is now available on the market or may be easily constructed.

Many of the experiment stations have made important contributions to the efficient use of electricity on the farm and in farm homes, with the result that such use of electricity has greatly increased in recent years. It is reported that 1,000,000 farms and farm homes now use electricity. A recent report of the Washington station, cooperating with the Washington Committee on the Relation of Electricity to Agriculture, shows numerous ways in which electricity is or can be used to advantage on poultry farms.

Electric dairy-utensil sterilizer.—The California station, in cooperation with manufacturers and dairymen, has produced an electrically heated dairy-utensil sterilizer that can be bought for less than $100 and is economically operated. A new industry supplying a much-needed piece of dairy equipment has thus been developed.

Electric hotbeds.—Until recently the heat necessary for the operation of hotbeds was usually supplied by the fermentation of stable manure. This practice did not permit of regulation to meet variations in outside temperature. Furthermore, stable manure became scarce and expensive. The California, Idaho, Maryland, Missouri, New York Cornell, Oregon, and Washington stations have met the situation by developing electric-heated hotbeds. It has been found that the advantages of electrical heating of hotbeds are that the installation may be made permanent, and the temperature in the hotbed may be maintained and adjusted automatically to the needs of any particular plant. It is also possible to control the air- and soil-temperature ratios. These features permit the forced growth and early maturity of spring vegetables and aid the truck gardener in meeting out-of-season competition. The permanency of the installations saves considerable labor when compared with the manure beds, and the installation and operating costs of the electric hotbeds compare favorably with those of beds using any other type of heat when low-cost current is available. Manufacturers of electrical equipment have cooperated in these studies, with the result that special electrical soil-heating elements have been developed and are now available for general use.

Design of tillage implements.—Tillage, including both seed-bed preparation and cultivation, requires the expenditure of more power than any other agricultural operation and is the limiting cost factor in the production of many major crops. The design of tillage tools, in-

cluding plows, has been largely of a speculative character covering a wide variety of conditions and requirements, and until recently there was no basis for properly adapting tillage tools to different soil conditions. The result often has been waste of power, unsatisfactory tillage, and excessive overhead cost for equipment. The Alabama station has found that plow draft is a function largely of the shear and friction values of the soil and has worked out for different soils the relation between the action of a plow in the soil and the measurable dynamic properties of the soil. Applying these principles in studies of the shapes of plow moldboards it was found that all moldboards which perform satisfactorily follow certain general laws. The principle of uniform pressure of turning and pulverization was found to apply to all plows studied and could be expressed mathematically. A way was thus opened for intelligent selection and proper adaptation of plows for definite soil conditions, with reasonable assurance of optimum performance and minimum power requirement.

Air cleaners for tractors.—The cost of maintaining and repairing internal-combustion engines for tractors, automobiles, and stationary uses on farms has been found excessive in relatively dry areas where the dust from the soils contains a high percentage of material of colloidal fineness. Studies by the California station showed that it is this extremely fine dust material which gains access to the moving parts of internal-combustion engines, mainly through the air intake, and causes wear of the bearings, cylinders, rings, pistons, and crank pins. The station further discovered the physical and mechanical principles that must be employed in intake air cleaners in order to exclude the abrasive dust fraction. Manufacturers have taken advantage of the information thus obtained and are rebuilding and improving air cleaners in accordance with the findings of the station, thereby saving tractor owners and users in California between $1,500,000 and $2,000,000 annually on engine repairs.

Efficient use of tractors.—Studies by the Montana station of the use of tractors indicate that many of the 20,000 farm tractors in that State run very inefficiently and with large losses to the farmers of the State. One of the largest causes of loss was found to be bad combinations of power and machinery in relation to the size of farm. By substituting the lister for the plow, and using a 1-way disk and a rod weeder, the cost of caring for an acre of summer fallow was reduced from $3.25 to $1.53. With fully 1,250,000 acres in summer fallow in Montana, this means a saving of nearly $2,000,000 annually.

IMPROVING QUALITY OF THE PRODUCT

The production of commodities that will appeal more strongly to consumers and command a better price and net return is a major aim of experiment station work. Investigations with this object in view cover a wide range of plant, animal, and dairy products, as the following partial review shows.

Improvement of Plant Products

Cotton.—Studies on relation between the quality of cotton lint and the market price, made by the Georgia, North Carolina, and South Carolina stations cooperating with the Department, have stimulated interest and activity in producing cotton of better quality. The North Carolina station states that the cotton crop of that State has been changed from poor-quality lint, largely exported, to superior quality, consumed in local mills, thus adding no less than $400,000 annually to the value of the cotton crop of the State. The South Carolina station reports a material improvement in the quality and price of cotton as a result of its investigations. The premium received for the cotton of improved quality exceeded $5 per bale, even at the low price obtaining in 1931, and resulted in an added income to the State of more than $1,225,000 in that year, the total production for the State remaining approximately the same.

Potatoes.—Consumers' preferences in potatoes have been studied by the New Hampshire station, the study showing that New Hampshire consumers, at least, are not satisfied with a large part of the potatoes they are now buying. "This is especially true in regard to size of stock; many people are forced to buy smaller potatoes than they care to use." From the standpoint of consumers' preferences, as shown in this study, potatoes should be, in the order named, mealy, dry, white, smooth, solid, uniform in size, and not soggy. The study made it clear that "growers will have to revise many of their growing, handling, and grading practices if the wishes of the consumer are to be satisfied."

Comparing the table quality of three well-known varieties of potatoes (Irish Cobbler, Green Mountain, and Rural Russet), grown under different conditions of fertilization, the Rhode Island station found that the Green Mountain scored highest for color and the Rural Russet for flavor, and the Green Mountain slightly higher than the others for mealiness, and that high fertilizing with potash salts increased mealiness of the boiled, mashed, or baked potatoes, the muriate (chloride) of potash being more effective in this respect than the sulphate. There was no significant difference in mealiness of the three varieties tested. Apparently there was no direct relation between mealiness and starch content.

Potatoes stored in a cellar for several months at temperatures ranging from 38° to 42° F. were found by the Wyoming station to be of very poor quality on account of the sweetish flavor. However, they reached a normal state of palatability when stored from 20 to 40 days in a dry basement where the temperature range was 50° to 60°. This suggests that potatoes that have deteriorated through being kept in storage at temperatures that were too low can be reconditioned by storing them for 3 to 6 weeks in a moderately cool warehouse or basement. In comparative cooking tests of the Bliss Triumph and Irish Cobbler, the latter ranked higher in mealiness when first dug and in standing up under storage conditions in moist potato cellars. After storage from early fall until late in June, the dryland Bliss Triumph potatoes scored lower than the irrigated Irish Cobblers. The New York Cornell station has found that potatoes kept better and suffered less loss from rots if stored at a temperature of about 65° for the first 10 days instead of at 40° as is customary. The higher initial temperature tends to cause thickening and toughening of the skin, thus affording added protection of the tubers. After the first few days at the higher temperature the usual low temperature should be maintained.

Hay.—Curing and storing hay presents many difficulties, especially in humid regions. Appearance and nutritive quality are frequently impaired by untimely rains or undue exposure to sunlight. For example, the Colorado experiment station found that a heavy rain during the curing process reduced the vitamin A content of alfalfa hay as much as 50 percent and that the action of sunlight during the process caused large losses of both vitamin A and vitamin B_1.

A method of curing and storing alfalfa hay, recommended by the Iowa station, is—

> to allow the cut hay to remain in the swath until it is well wilted but not dry, then windrow and leave undisturbed until sufficiently cured for placing in the mow. In the event that the hay becomes wet by rains or heavy dews the windrow may be turned to advantage.

The station found it safe to store the hay in the mow when the moisture content was reduced to 27 percent.

With the advent of the mechanical drier for curing hay, considerable interest in its effect on the dried product as well as its economic efficiency has been aroused. The New Jersey station found the vitamin A content of artificially cured hay to be greater than that of hay cured on the ground during rainy, cloudy weather. Momentary exposures of hay to high temperatures resulted in no loss of vitamin A when compared with the same hay cured under good haying conditions. The Indiana station found that artificial drying tends to preserve the vitamin A content of alfalfa, while field curing is rather destructive of this vitamin.

The Pennsylvania station found that a mixed timothy and clover hay of apparently high quality can be produced by artificial drying. The drier used by the station, when working efficiently, reduced the moisture content of green material from 70 to 75 percent to 7 to 10 percent. Heifers fed the mechanically dried hay, however, did not grow as rapidly as those fed a similar sun-cured hay and were less thrifty. The Vermont station has obtained a highly nutritious feed by artificially drying young grass.

The nutritive value of the dry matter, protein, and calcium was found by the Wisconsin station to be as high in artificially dried alfalfa as in hay completely or partly field cured.

Best stage of maturity for marketing fruits.—Producers of apples, pears, and plums, especially for distant markets, have been seriously handicapped in the past by a lack of reliable methods for determining when the fruit should be picked to secure the best market quality. If gathered too early, fruits may keep satisfactorily but never attain desired quality; gathered too late, they soften and decay before reaching the consumer. The subject has been investigated by the Department of Agriculture and a number of experiment stations, including those of

Idaho, Maryland, Mississippi, New Hampshire, New Jersey, Ohio, Oklahoma, Oregon, and Washington, with the result that simple pressure testers for determining the firmness of the fruit have been perfected and have come into wide use to the great advantage of both grower and consumer, since they reduce losses to the former and give a fruit of better quality to the latter.

The condition in which peaches reach the consumer and the prices they bring depend especially on the stage of maturity at which the fruit is harvested. The Washington station found a combination of pressure test and color a satisfactory means of determining what stage of maturity is best suited to storage, and suited to storage and shipment. Fruit that was hard and green when harvested shipped well but was of inferior quality when ripened and unattractive to the consumer.

Better color in fruit.—The general belief that the color of fruit is influenced by fertilizers has been confirmed by the Montana station, which has found that fertilizers containing phosphoric acid and potash tend to improve the color of McIntosh apples and of sweet and sour cherries, as well as to increase the size and yield.

Improving fruit juices.—The preparation and use of fruit juices is assuming large proportions, and many experiment stations are attempting to show how juices of high quality adapted to various uses may be made.

A very thorough study of undesirable changes taking place in citrus juices after extraction and of means of preventing such changes has been made by the Florida station, cooperating with the Department. It was found that the bitter taste which often develops in such juices on standing is due to certain extractives from the inner peel, veins, and the wall lining of the sections of the fruit, and that variations in color and slowness of clarification on standing are due in part to oils derived from the outer peel of the fruit. Ways of improving the appearance and flavor of the stored juices were suggested by the study.

Improving jelly making.—Improvement of the process and product of jelly making has resulted from the work of the California, Delaware, Florida, and other stations. The California station has developed improved methods for the commercial manufacture of plum, Logan blackberry, and citrus juices containing a sufficient quantity of the natural pectin of the fruit to jell readily when heated with equal weights of sugar, as is done under ordinary household methods, and this insures an improved product. A new type of jelly tester, designed by the Massachusetts station, has advantages which it is thought will enable manufacturers of jellies or canned cranberry sauce to control the consistency and thus improve the quality of these products.

Better grading of dried prunes.—A simple specific gravity method of judging the quality of prunes has been perfected by the California station, which has issued practical instructions for making the test. Methods of grading based on the same principle have also been developed by the Oregon station and are in practical use by growers.

Improving the quality of canned prunes and peaches.—The California station reports that the quality of commercially canned prunes and peaches may be improved by increasing the acidity to prevent browning and other undesirable changes. Addition of citric acid to the sirup used in canning prunes is recommended. To prevent darkening of peaches, momentary dipping of the fruit in dilute hydrochloric acid after the lye peeling and before the customary rinsing of the fruit is recommended.

Improving frozen-pack processes and products.—The adaptation of the frozen-pack method to the preservation of high-quality products has raised many questions about selection of material best suited to the process, the procedure to be followed in each case, the final food value of the product, and how the product should be handled in use. A number of experiment stations are actively studying these questions. The Georgia station, for example, has found that the frozen-pack process gives best results with such fruits as figs, grapes, and tree-ripened peaches which do not ship well in their fresh state, and that while it is particularly adapted to highly flavored, highly colored, and rather acid small fruits with special precautions it may be used in preserving practically all fruits and most vegetables in good condition. The station has shown how the process may be improved and adapted to different materials and how the product can best be handled by the consumer.

The Massachusetts station has shown how the processing of fruit for use in frozen dairy products may be greatly improved. For example, the station

has confirmed the findings of California and the Department that freezing fruits in 40 to 50 percent cane-sugar sirup gives as good results as standard sugar pack (2 or 3 parts of fruit to 1 of sugar) and that strawberries, cherries, peaches, raspberries, plums, and cranberries can be preserved satisfactorily by being frozen with sugar or sugar sirup. The great economic importance of such work is indicated by the fact that—

in 1931 approximately 350,000,000 gallons of ice cream, besides sherbets, ices, and mousses, were produced in the United States. Of this immense amount, 15 to 16 percent, or 55,000,000 gallons, consisted of fruit ice cream. Strawberry, raspberry, pineapple, peach, cherry, and orange were the principal fruits used, though many others were utilized to a lesser extent. Strawberry made up 8 percent of the total—28,000,000 gallons. Next in importance came orange-pineapple.

The benefits of such work accrue not only to the fruit grower but also to the dairy industry and to the manufacturer of frozen dairy products in widening the market and increasing the price (p. 37).

The effect of the frozen-pack process on the quality of vegetables has been investigated by several stations. The California station, for example, has found peas, string beans, and spinach blanched for a short time and then preserved by freezing storage to be superior to the same vegetables frozen raw or after being blanched for long periods. Corn frozen on the cob and in the husk proved satisfactory.

In investigations designed to improve the product and expand the market for frozen vegetables, the New York State station found that varieties of peas commonly grown for canning are not so suitable for commercial freezing as are the high-quality market-garden varieties such as Thomas Laxton, Gradus, and Telephone. High-quality varieties of sweet corn of uniform color such as Evergreen, Crosgreen, Red Evergreen, and Golden Bantam, made especially attractive and fine-flavored frozen products. Methods of harvesting and handling were also found to be important in securing a high-quality product.

Studying frozen foods in relation to health, the Massachusetts station found that the bacterial count of frozen foods is low but increases very rapidly after defrosting. For this reason it is emphasized that frozen foods should be treated as perishable products and used within a few hours after being defrosted.

Sauerkraut of better quality.—A substantial improvement in the quality of sauerkraut, the Wisconsin station found, may be secured by washing the cabbage before shredding and packing it. This eliminates many organisms which, during the fermentation process, tend to give undesirable flavors and odors, and thus impair the quality of the product. The New York State station has recently reported studies of the quality of commercial sauerkraut and the relation between temperature and the rate of fermentation of the product, which indicate ways of improving the process.

Preserving extracted honey.—To preserve the quality of extracted honey, the Wisconsin station found, the honey should be stored at low temperatures, preferably 40° F. or lower.

Improvement of Animal and Dairy Products

Improvement of animal and dairy products is a major line of work of the experiment stations. A few examples of recent station investigations and accomplishments in the improvement of quality of such products are briefly reported in the following pages.

Steer versus heifer beef.—Factors that affect the quality of beef have been the subject of extended investigations by many of the experiment stations, usually in cooperation with the Department. One feature of this work has been a comparison of the quality of steer and heifer beef. The Iowa station has found little difference between steer and heifer beef in quality, as measured by distribution of lean, fat, bone, and tendon, and tenderness, color, and palatability when cooked. Heifer beef became fatter than steer beef as the period of feeding advanced. Comparing choice yearling Shorthorn heifers and steers as to the quality and palatability of the beef produced, the Missouri station found that the steers dressed slightly higher than the heifers but graded slightly lower in the carcass. Cooking tests showed little difference in quality. The carcasses of lightweight heifers proved to be as desirable as those from similar steers, but heavyweight heifers produced carcasses slightly more wasty and had a less desirable conformation than similar steer carcasses. From the standpoint of both the producer and the consumer it is considered usually more satisfactory to market fat heifers at weights of less than 725 pounds.

Quality of grass-fed beef.—Grass-fed beef is discriminated against in some markets on the ground that it is darker

than grain-fed beef, but results of investigations by the Kansas and West Virginia stations among others do not seem to justify such discrimination.

Hardening soft pork.—Production of soft pork has been the cause of large losses to hog raisers in districts where softening feeds like peanuts, soybeans, and others are commonly used. The North Carolina station reports, as a result of experiments extending over a number of years, that pork softened by feeding peanuts may be improved by finishing on rations containing cottonseed meal.

Improving the market quality of eggs.—In a study of factors influencing the quality of eggs, the New Mexico station found the feeding of cottonseed meal and of excessive amounts of green feed (alfalfa) to be major causes of poor market quality in eggs. The importance of producing infertile eggs, keeping them cool, and storing them fresh was demonstrated by the station. Eggs stored in April kept best. Eggs produced in June were of inferior quality. The station reports that as a result of these investigations interest in producing market eggs of better quality has increased, so that New Mexico eggs are now finding a ready market both for immediate consumption and for storage.

Investigating the opinion prevailing in certain terminal markets, "that southern eggs are generally unsuited for storage", the Louisiana station found that eggs produced according to accepted practices in Louisiana, properly cared for, and marketed while fresh can be successfully stored for 6 to 8 months under commercial storage conditions without excessive loss. The station found, however, that feeding cottonseed meal to laying hens may impair the internal appearance and keeping quality of eggs, and the station therefore recommends that cottonseed meal be not fed in producing market eggs.

Feed as related to the vitamin content of milk.—The Ohio station reports that milk produced by cows on pasture contains more vitamin G than does milk produced on dry feed. Cows on early pasture in a vigorous state of growth produce milk containing more vitamin G than do those on late pasture. The effect of pasture on the vitamin B content of milk was less evident, but early pasture appeared to have a more favorable influence than late pasture.

Improving the whipping quality of cream.—Means of improving the whipping quality of cream have recently been reported by the New York State and Wisconsin stations. The method developed by the former station is adapted to factory use and is being used with satisfactory results in commercial plants. It consists essentially in warming cream at 40° to 80°–84° F. in 3 to 10 minutes in an internal tubular heater and cooling it again to 40°–48° in the same length of time in an internal tubular cooler. The method proposed by the Wisconsin station consists simply in adding 0.4 percent of sodium citrate to the cream.

Improving the keeping quality of frozen cream.—The keeping quality of frozen cream, that is to be held in a frozen condition and later used in making ice cream, can be improved, according to the Wisconsin station, by the addition of 15 percent sugar (sucrose) to the cream. The Massachusetts station found that by adding 10 percent of cane sugar to sweet cream, manufacturers of ice cream are enabled to store the large surpluses of sweet cream for use months later without any off flavors in the ice cream.

Improving the texture and flavor of butter.—The California station has developed methods of improving the sticky, crumbly textured butter that results from feeding exclusive rations of alfalfa hay. The finding is of great value to dairymen and manufacturers of butter in regions where alfalfa hay is used as an exclusive ration for dairy cows during the winter.

Surface taint of butter is easily recognizable by experienced judges, but its cause and correction have not been positively known. The Iowa station has found that—

> the defect is essentially one that develops after the butter is made. At comparatively high holding temperatures it may develop rather quickly and be noticeable in butter a few days after manufacture, while at about 5° C. (41° F.) 10 days or more may be required for it to be evident.

Strict attention to creamery sanitation, proper salting, use of butter culture, and careful control of temperature are suggested as means of preventing the trouble. The Washington station has shown the importance of careful grading of cream used in butter making.

Cheese from hard- and soft-curd milk.—In further study of hard- and soft-curd milks the Utah station found the yield of cheese from soft-curd milk to be low and the fat loss in the whey high as compared with cheese made from hard-curd milk. Soft-curd cheese ripened much faster than hard-curd cheese, but it had a greater tendency

to develop off flavors, was brittle and soft, and the flavor and keeping qualities were very inferior.

Producing ice cream of better quality.—Consumption of ice cream furnishes a large and constantly increasing market for milk and cream, as well as fruits. Improvement of the product, particularly fruit ice creams, has been a major subject of recent investigation by many stations.

Flavoring strawberry ice cream during the winter is an important problem for the commercial ice-cream manufacturer. The Iowa station found that strawberries packed at the rate of from 2 to 3 pounds of berries with 1 pound of sugar and frozen at 20° F. were superior to canned strawberries, and both were superior to strawberry extract for flavoring. Ripe strawberries and late-season strawberries gave a better flavor to ice cream than berries picked for shipment or early-season strawberries. The Massachusetts station found that approximately 15 percent of frozen-pack strawberries gave an optimum flavor to the mix. The station recommends that in order to obtain the maximum fruiting flavor and distribution, the fruit be added to the mix directly after the freezing operation is started.

Ice creams flavored with frozen fruits were found by the Massachusetts station to deteriorate rapidly in flavor during storage unless the fruit had been heated to 165° F. for 20 minutes before it was used, to destroy fruit enzymes, which have the power to oxidize butterfat and thus impair the flavor. Adding 10 percent of sugar to the cream before freezing it for storage and later use in ice cream improved the body and flavor of ice cream made from it as compared with ice cream made from unsweetened cream. Strawberries frozen with one third their weight of sugar were found to fully retain their vitamin C potency and to produce ice cream of the best quality.

Honey can be used to advantage in ice cream, the California station has shown, when its price is sufficiently low to justify its use as a substitute for sugar. Other stations have gotten similar results.

The relation of rapid freezing to texture of ice cream has been studied by the California station, with the result that commercial methods of freezing have been modified to secure a cream of smoother texture.

Certain off flavors in strawberry ice cream were found by the Pennsylvania station to be due to an excess of copper coming from the condensed milk used, nearly all of which is made in copper pans. The Wisconsin station has shown that a small contamination with copper, which would not affect the quality of fresh cream, may seriously impair flavor during storage, and also that any method which lessens the amount of free oxygen in the stored cream aids in preventing development of bad flavors.

FINDING NEW USES FOR FARM PRODUCTS

Finding new uses and thus extending the markets for farm products, by-products, and wastes is a leading object in a wide range of investigations by the experiment stations and the Department of Agriculture. Some significant results of recent work of this kind, in addition to those referred to elsewhere (p. 34), are reported hereafter.

Fruits and Vegetables

Fruit juices.—The New York State station is making the discovery of new ways and means of disposing of farm products, particularly fruits and vegetables, a leading feature of its research program and has recently developed and released for practical use an efficient process for preparing clear, sparkling beverages from fruit juices. It is believed this process will open a profitable market for different kinds of fruits and fruit products. As already stated (p. 34), the Florida station, among others, is engaged in similar lines of work. The Massachusetts station has found a way to use cranberries that are not well suited to other purposes in preparing a beverage and as a blend in other products, thus extending the market for this fruit.

Frozen-pack products.—As already indicated (p. 34), the frozen-pack method of preserving fruits, vegetables, and other products has opened up great possibilities of extending profitable markets for various farm products. The Georgia station, among others (p. 34), has shown that a great variety of choice but quickly perishable fruits can be preserved by this process and thus made available, even in distant markets, at any season of the year. As already stated (p. 34), the process is especially well adapted to peaches, grapes, figs, and other fruits not well suited to being marketed in the natural state.

Use of fruits in ice cream and similar products.—The extensive use of processed fruits in ice cream and similar prod-

ucts has already been referred to (p. 35). Improvement in the processing of fruits for this purpose is now going forward rapidly at a number of experiment stations; as a result, the demand for fruit products is steadily increasing and the market for such products is constantly widening.

New ways of utilizing surplus ripe apricots in the preparation of products suitable for use in ice cream, soda-fountain drinks, and the like have been recently perfected by the California station.

Jelly from sweetpotatoes.—The Tennessee station found that a jelly of good quality can easily be made from the sweetpotato. From a bushel of the Nancy Hall variety of sweetpotatoes, the station made nearly 200 glasses of jelly which appeared to be suitable as a basis for making mixed jellies of different kinds and of desirable quality.

Waste Products and By-Products

Citrus pulp residue, apple pomace, and similar waste products.—Citrus pulp residue, of which 50,000 tons is produced annually in California, has been shown by the California station to have about four fifths of the feeding value of beet pulp and, at normal feed prices, to be worth from $100,000 to $200,000 annually. The station has shown the possibility of utilizing this and other agricultural waste products to good advantage as feeds. Dried apple pomace has been shown by the Washington station to furnish a palatable feed for dairy cattle and to have only slightly less value than dried beet pulp. This indicates a profitable use for an industrial by-product which has heretofore largely gone to waste. The Virginia station has also demonstrated the value of apple pomace as a feed.

Peanut meal and rice by-products.—The Virginia station has found that peanut meal, a product of considerable local importance, can, if supplemented with minerals, replace 50 percent of the meat scrap in poultry rations without diminishing the growth of chicks. Such use of the meal would help both the poultry raiser and the peaunt industry. The Arkansas station has shown that rice bran, rice polish, and brewers' rice have distinct value as feeds for poultry and swine.

Molasses as feed.—Blackstrap molasses, a relatively cheap by-product of the sugar industry, the Louisiana station found, can effectively and economically replace corn to the extent of 9 pounds daily in rations for work mules, thus reducing the cost of maintenance and providing an outlet for this by-product.

Use of skim milk in the manufacture of ice cream.—The Pennsylvania station reports that spray- or vacuum-process skim-milk powders can be used with good results to supply as much as 10 percent of the total solids of the ice-cream mix when fresh cream and milk are used to supply the butterfat and the remainder of the solids.

Farm-Management Adjustments

Investigations having as their object more efficient farm organization and management, better utilization of land, and the establishment of new crops have been carried on by practically all experiment stations, in many cases in cooperation with the Department of Agriculture. A few examples of such work recently reported are cited below.

Improving farm organization.—A study of dairy-farm organizations in southeastern Kansas, made by the Kansas station, suggested reorganizations which it is estimated would give the operators an increased return of $397 on an 80-acre farm, $622 on a 160-acre farm, and $1,093 on a 320-acre farm over the returns from typical farms under present plans of organization.

Following studies of the crop-production and livestock possibilities of the Red River Valley, the Minnesota station outlined systems for farms of 240, 400, and 600 acres, which it is estimated would give returns above the cash costs $250, $1,760, and $3,724 greater, respectively, than those being obtained from farms of similar size under present organizations.

On the basis of a study of the records of 205 general farms, the Kentucky station has worked out systems of organization for 80-, 150-, and 200-acre farms which it is estimated would give net returns of $1,244, $1,830, and $2,101 for labor, management, and capital.

Reorganizations of the wheat-producing area of north-central Oklahoma, outlined by the Oklahoma station, it is estimated would result in an increase of nearly $1,000 in the labor income for a typical 160-acre farm and approximately $340 for a typical 442-acre farm.

The possibility of increasing farm income in the piney woods area of northeastern Texas $200 to $300 per year by combining dairying, or such crops as tomatoes, sweetpotatoes, watermelons, and peas, with cotton

growing was shown in investigations recently reported by the Texas station.

Poultry raising has been shown by the Alabama station to be a valuable adjunct to cotton farming, resulting in increased income with more even distribution of labor during the year.

To obtain, in growing field beans, a farm income greater than a hired man's wages, the New York Cornell station found it necessary to have a farm production of at least 200 bushels and receipts double the cost of labor, including operator's time, and equal to about 25 percent of the capital used.

The elimination of unprofitable methods and types of farming has been the object of extensive study by the Illinois station, and the results have furnished a basis for important adjustments and improvements in the farming systems of the State.

Land utilization.—Investigations having as their object the determination of types of land that can be economically used for different agricultural purposes, for forestry, or for a combination of agriculture and forestry, and to point out lines of improvement in the utilization of both farm and forest lands in various typical areas, have recently been reported by the experiment stations of Indiana, Kentucky, Ohio, West Virginia, Wisconsin, and other States, usually in cooperation with the Department of Agriculture.

The need of better coordination of agriculture, forestry, and related industries and enterprises is suggested by a study reported by the Kentucky station, which also shows that one of the most serious handicaps of farming in marginal areas is the small amount of available crop and pasture land per farm.

Investigations on use of lands for pasture have been reported by the Indiana station, on recreational use of lands by the Wisconsin station, and on various possible uses of marginal lands by the West Virginia station.

The advantage of transferring certain marginal lands from cultivation to forests is suggested by investigations reported by the New York Cornell station, which has been influential in bringing about many beneficial local and State-wide adjustments in farm management.

Establishment of new crops.—Striking examples of new crops established by the experiment stations cooperating with the Department are crotalaria in Florida, Korean lespedeza seed in Kentucky, and sugar-beet seed in New Mexico. The growing of Korean lespedeza seed in Kentucky, originated from seed supplied by the Department of Agriculture in 1924 and tested and distributed to farmers for trial by the Kentucky station, now occupies 200,000 to 300,000 acres in that State and produces 3,000,000 pounds of seed annually. As a result of investigations by the Florida station, cooperating with the Department, species of crotalaria are now grown annually on about 50,000 acres in Florida for soil improvement and as a forage and hay crop and have made possible better utilization of the sandy upland soils of the State.

IMPROVING MARKETING

Investigations having in view the improvement of marketing methods and practices were reported during the year by a number of experiment stations. Among the subjects of these investigations were various phases of cooperative marketing and the relation of supply and quality to demand and price.

Cooperative marketing resulting in more uniform product, reduced cost, and more orderly distribution has been distinctly advanced by the work of the experiment stations. Investigations on cooperative marketing of poultry products and milk were reported by the California station; on cooperative shipment of eggs by fast freight in refrigerator cars, by the Indiana station; on cooperative strawberry-marketing associations, by the Kentucky station; on cooperative creameries, by the South Dakota and Vermont stations; on cooperative marketing of tobacco, by the Virginia station; and on cooperative livestock-shipping associations, by the West Virginia station.

Eggs.—As a result of a study of conditions under which eggs are marketed in Los Angeles, the California station made recommendations which have greatly improved the cooperative handling of this commodity and strengthened the cooperative association.

In a study of the cooperative shipment of eggs by fast freight in refrigerator cars, the Indiana station found that the freight charge on shipments to New York City in carload lots was 97 cents per case less than that for individual shipments by express. Shipments of 160,719 cases by five associations from March 1928 to Novem-

ber 1931 gave the shippers a net gain of $253,100 over the highest prices offered locally on the days on which the eggs were loaded. The net gain for one association shipping 25,260 cases during 1929 was 7.8 cents per dozen. A considerable portion of the increased price was due to high quality of eggs, which is encouraged by the fact that the price received by the farmer is determined by the grade given him by his chosen receiver in New York City.

Milk.—The problem of obtaining an adequate year-round supply of fluid milk for cities without great surpluses during certain periods has been investigated by the experiment stations of several States in which large cities are located. The price to be paid to producers is in most localities a source of friction between producers and distributors, and frequently leads to milk wars which result in severe losses to both producers and distributors and in great hardship to consumers.

In a study of the milk supply of the New York City market, the New York Cornell station found that the problem of meeting the increased city demand for milk has been met during the past few years by expansion of the milk shed into the manufactured-milk territory, by stimulation of production, and by a shift in seasonal production. The first two methods tend to increase the surplus supply during the greater part of the year. Consequently, the best solution of the problem appears to be a gradual shift in seasonal freshening of cows so that production will conform to seasonal demand. The study showed that if this change can be brought about properly, the present approved milk shed is capable of supplying the New York City market for many years to come.

As a result of a study of the Los Angeles milk market after the milk war in the fall of 1930 in the East Bay cities of California, the California station was requested to study the economic factors affecting the marketing of whole milk in the area. Many of the recommendations made as a result of the study were put into effect. Producers and distributors in many other California cities are reorganizing their markets along the lines suggested by the Los Angeles and East Bay area studies.

Corn prices.—In a study of factors influencing corn prices, the Minnesota station found that the supply of corn available for consumption in the United States is the most important factor and that the maximum value of the corn supply occurs when the crop approximates 80 percent of the normal crop. Other factors shown to be of some consequence are: (1) The proportion of the corn supply in the cash-corn area immediately surrounding the Chicago market, an increase of 10 percent in such proportion being about equivalent to a decrease of 4.1 percent in the supply; (2) quality of the crop, an increase of 5 percent in the quality having about the same effect as 1.5 percent increase in the supply; and (3) number of hogs on farms, an increase of 10 percent in hogs having an effect about equivalent to that of a 2.9 percent decrease in the supply. The amount of oats and barley produced and the number of beef cattle on farms appeared to have only a minor influence on the price of corn.

Quality and price of cotton.—Studies of the relation between quality and price of cotton in local markets, reported by the Arkansas station, showed the need of better grading of cotton in the local markets in order that individual farmers may be paid more nearly the central-market prices and staple premiums and discounts than they receive under the present method of selling in local markets. The station concludes that attempts to improve local marketing practices should be directed primarily toward (1) giving farmers the benefit of better cotton-classing services, and (2) otherwise increasing the bargaining power of individual growers.

Marketing of potatoes.—The method of marketing potatoes has been shown by the Pennsylvania experiment station to have a marked effect on the net prices received by growers. Records for 1928 of 450 growers showed an average farm price, to consumers at the farm, of 80 cents per bushel; of sales to truckers, 54 cents; of potatoes hauled to market, 57 cents; and of those shipped by rail, 44 cents. Records for 1931–32 of 17 growers marketing a good grade of no. 1 potatoes in 15-pound sacks showed that 11 lost from 4 to 20 cents a bushel by so marketing, 3 broke even, and 3 profited by 5 to 17 cents a bushel. The returns, however, in advertising value, ability to move the crop, and the development of new markets were more important than the direct financial returns from the use of the small containers. The station concludes, as regards this method of marketing, that:

> Marketing potatoes in 15-pound containers appears to offer little advantage to the Pennsylvania potato industry, at least during the next few years. A few grow-

ers may be able to use this special package advantageously in their marketing program. A limited market exists for a good quality potato in a consumer-size package. The grower must find a trade that will pay for the service before this method of marketing will be profitable. Thus far, in most cases, the trade has been unwilling to pay the additional price for the bag alone, and also has expected to obtain a superior quality of product in the small package. As long as the small bag serves as a means of identifying quality, it has some advantages.

Tobacco.—The Virginia station reports that—

tobacco production in Virginia is decreasing because of the low prices received for the crop in comparison to the prices received for other farm products, and will probably continue to decrease because Virginia growers are not willing to continue to accept the low standard of living necessitated by the returns from the crop.

The station finds that the methods of marketing—

could be improved by the elimination of the auction warehouses which sell only very small volumes of tobacco at prices considerably below those paid in the larger markets. The cooperative marketing of tobacco, where the cooperative marketing association operates as a sales agency under the auction system but sells according to Federal grades, could improve the present marketing condition in Virginia by narrowing the spread in the price paid for tobacco of the same grade.

It is suggested also that—

a more uniform flow of tobacco to market throughout the season should reduce the cost of marketing because it would make possible a reduction in the number of warehouses required to handle the crop.

Alfalfa hay.—The average yearly price of alfalfa hay in California was found by the California station to depend primarily on the size of crop, number of dairy cows in the State, and the price of feed concentrates used in the dairy ration. Of the increase in the average tonnage of alfalfa hay raised in the State from 1919–21 to 1928–30, 30 percent was due to increased acreage and 70 percent to increased yields per acre. A change in production of one-fourth ton per cow resulted in a change of $1 per ton in the Los Angeles price of alfalfa hay, and a change of $1 per ton in the weighted average of feed concentrate prices tended to change the price of hay 55 cents per ton.

The keeping of pecans in storage as related to market quality has recently been investigated by the Alabama station, which found that the nuts can be kept in good edible condition for more than a year at temperatures around 32° F. and with low humidity. At 50° the nuts showed marked deterioration in 6 to 10 months.

Selling tomatoes on a grade basis.—The advantage of buying or selling farm products on the basis of standard grades has been demonstrated in many cases by the experiment stations and the Department. Selling tomatoes to canneries on the basis of grade has been shown to bring higher returns to both growers and canners by increasing the percentage of the raw stock that is canned and by raising the grade of the pack. The Ohio station reports that in 1930 growers selling to canneries on a grade basis received an average of $1.38 per ton more for tomatoes, delivered, than they would have received if the tomatoes had been sold at the usual flat-rate prices. The net cost of canning was $3.45 higher per ton of raw stock, but the sale value of the product was $7.86 higher. At five of the factories it was possible to can 34.8 percent of the raw stock, and 58.1 percent of the total pack graded Fancy or Extra Standard, as compared with averages of 28 percent canned and 42.8 percent Fancy or Extra Standard during the preceding 5 years. The station concludes that:

The marketing of cannery tomatoes on grade and inspection results in (*a*) greater returns to growers; (*b*) lower labor costs and higher net returns to canners; (*c*) improved quality and larger volume of finished products per ton of raw stock; and (*d*) more equitable relationships between growers and canners.

Many other examples of station work that are aiding in the improvement of marketing methods and practices might be cited. Much of the work reported in other sections of this review has an important bearing on the subject.

RURAL-HOME AND RURAL-LIFE BETTERMENT

Practical benefits of the results of experiment station work relating to rural-home and rural-life betterment are becoming increasingly evident in improved food and dietary habits of rural people, greater and better use of farm food resources and household equipment, more efficient and less burdensome use of the home maker's time, better clothing and housing, improved social conditions, and in many other ways.

Use of Farm Food Resources

Recent experiment station investigations into what the farm does or may contribute to farm-family living are especially timely in view of present low prices of many farm products. From studies of this kind, the Michi-

gan station concludes that "the farm family offers the best market for such farm products as can be used in the home" and that "many more farmers are making their farms more self-sufficing than has been the case for the past decade." In many cases, the station finds, the advantage from such use of farm products "may equal or exceed the financial returns from the operator's labor and management."

The average value of home-grown products used on the farms studied by the Michigan station was $372 per farm, varying from approximately $200 to $700. The products most largely used were milk, cream, butter, eggs, poultry, potatoes, pork, fruits and vegetables, and fuel. Incidentally, the study indicated that all the farms "could advantageously produce and use more home-grown meat." In similar studies the Minnesota station found that all of the milk, eggs, and potatoes, and much of the meat used by the farm families studied, was supplied by the farm. The Montana station reports studies which showed that of an average annual food cost of $945 per family, $604 was to be credited to products from the farm. Of food costs per man per year, varying from $120 to $134, the Ohio station found, 55 to 59 percent represented food grown on the farm. The Utah station found that of a total food cost of $505 per family per year, $258 represented products furnished by the farm. The largest farm contribution in this case was dairy products, of which 91.8 percent was home-produced. The farm also supplied 84.7 percent of the eggs used, 54.7 percent of the meat and poultry, and 26 percent of the fruits and vegetables. The Vermont station found that a little over one half of the average food cost of $161 per man per year represented the value of foods supplied by the farm, which furnished 95 percent of the milk, 81 percent of the potatoes and 78 percent of the other vegetables, a little less than 50 percent of the meat, and 20 percent of the sugar and sirup used. The Virginia station found that 80 percent of the food of the farm families studied was furnished by the farm. The food was adequate in amount, but deficient, especially during the winter, in fruits and vegetables.

The results of these and similar investigations indicate that by larger use of home-grown foods the diet of the farm home may be improved and its cost reduced, and are a significant contribution to the live-at-home program.

Cost of Farm Living

In investigations designed to answer, in part at least, the question "What does it cost to live comfortably on the farm?" the Montana station obtained records during 1929–30 from representative farm homes in the State. These records showed the average total cost of living per year (excluding automobiles, savings, and investments) for a rural family to be $1,919, made up of an average cash expenditure of $1,089, an estimated average housing provision of $220, and farm produce used in the home having an average value of $604. Of the total cost of living, 56.7 percent was purchased with cash and 43.3 percent was furnished by the farm. The Utah station found that with increased incomes the expenditures for food and household operation remained fairly constant, while those for clothing, advancement, life insurance, and use of automobile increased.

Nutritive Value of Foods

Many of the experiment stations, including among others those of California, Iowa, Massachusetts, Missouri, North Dakota, Tennessee, and Washington, have recently reported studies of the nutritive value of foods.

Vitamins.—A proper proportion of vitamins of different kinds is known to be essential to a well-balanced and healthful diet. Therefore the vitamin contents of many common food materials have been determined by a number of experiment stations.

Sweetpotatoes of the Prolific and Nancy Hall varieties have been shown by the Iowa, Missouri, and Tennessee stations to be rich in vitamin A and to furnish an excellent means of increasing the vitamin A content of the diet. In northern localities where it is difficult to raise sweetpotatoes, winter squash such as the new Buttercup variety noted on page 14 is suggested by the North Dakota station as a substitute source of vitamin A.

Canned tomatoes are recommended by the Iowa station as an important source of vitamin A, 1 serving (three fourths of a cup) furnishing nearly 3 times as much of this vitamin as 1 serving (1 tablespoon) of butter. Tomatoes canned in tin showed no loss of vitamin potency within 3 years.

Canned corn of the Golden Bantam variety was found by the Wisconsin station to be a rich source of vitamin A, but a white variety (White Crosby) harvested at the same stage of ma-

turity and canned in the same way was entirely lacking in vitamin A. An ordinary serving of the canned Golden Bantam corn was calculated to contain about the same amount of vitamin A as an ordinary serving of butter.

Dried apricots were found by the California station to be an excellent and inexpensive food source of vitamin A. Fresh figs were found to contain a fair amount of vitamin A, but dried figs very little.

Winesap apples have been found by the Washington station to be a fair source of vitamin C. The Massachusetts station reports the Baldwin apple to be a good source, the skin containing about 12 times as much of the vitamin as the flesh near the core, but that the McIntosh is very deficient in vitamin C.

Raw cranberries and wild blueberries have been found by the Massachusetts station to be approximately half as rich in vitamin C as oranges or tomatoes. Unstrained cranberry sauce retained about 80 percent of the vitamin C present in the fresh fruit, but the strained sauce, pasteurized juice, and dried fruit were practically devoid of the vitamin. Frozen cranberries, however, retained all of the vitamin C of the fresh fruit. Preliminary results indicated that cranberries contain small quantities of vitamins A and G.

The vitamin D content in common foods varies to some extent with the conditions under which the foods are produced and handled, the Wisconsin station has shown. For example, eggs produced during the summer were found to be richer in this vitamin than those produced in winter. The vitamin D content of eggs was increased by feeding the hens irradiated yeast.

Mineral constituents of foods.—Certain mineral substances are known to be essential constituents of food. The Wisconsin station, for example, has shown that copper as well as iron in foods are of value in preventing nutritional anemia. To food materials previously found to be good sources of iron and copper, the Mississippi station has recently added cowpeas and sorgo sirup, particularly sirup cooked in iron or copper pans.

Cooking Quality and Palatability of Foods

Because unavoidable errors occur in judging the quality of food products on the basis of purely subjective tests, some experiment stations are attempting to develop laboratory tests for such qualities as tenderness or doneness in cooked foods.

Pinto beans.—The home maker in New Mexico who uses the pinto bean as a staple food will benefit from studies made by the New Mexico station on the best methods of cooking these beans, with attention to time required and palatability of the product. The hardness of the water was found to be an important factor in determining the degree of palatability of the cooked product, and methods of controlling this factor were devised.

Meat.—The extensive meat investigations carried on by various experiment stations in cooperation with the Department of Agriculture are making contributions to the home maker—not only in improving the quality of meat, but in contributing better methods of cooking meat. Contributions of the year included methods developed by the North Dakota station for the surface-burner roasting of less tender beef cuts, with a comparison of sheet-iron and aluminum kettles for such cooking; further work by the Missouri station on the effect of oven temperatures on tenderness and other palatability factors of beef roasts and of broiling temperatures on cooking time, cooking losses, and palatability of steaks; and by the Minnesota station on the quality and losses in pork roasts cooked with and without being seared.

Housing and Home Conveniences

Housing is a part of rural living requirements which needs improvement, especially as regards modern conveniences, according to the Wisconsin station. More consideration, the station says, should be given to the suitability of the farmhouse to the family which occupies it. Too frequently, in selecting a farm for tenancy or ownership, more consideration appears to be given to the character of the farm and farm buildings than to the farmhouse and its suitability as a home.

Farm housing conditions, the Maryland station finds, have an important relation to migration of population. The length of occupancy of farmhouses by tenants was found by the station to be closely related to the condition of the houses and their improvements and equipment. Measured by length of tenancy, farmhouses which had furnace heat, bathrooms, and electricity and were well built and in good repair ranked high; those that scored poor in arrangement

and equipment and were crowded ranked very low.

The beneficial effect of station work in improving farm housing and surroundings is becoming evident in many ways.

Kitchens and Kitchen Equipment

The increasing use of more efficient equipment and methods in farm homes may be attributed to no small extent to the work of the experiment stations.

A survey of farm kitchens by the Arkansas station indicated the prevalence of unsuitable working conditions, inadequate mechanical equipment, and lack of storage facilities, due generally to limited family income. To aid in overcoming this situation, the station has prepared and distributed plans which simplify and cheapen the construction of kitchens and kitchen equipment and increase their convenience and efficiency.

Studies of kitchen conveniences and the expenditure of labor in kitchen work, made by the North Dakota and Washington stations, suggest that the high stool, at one time emphasized as an important part of kitchen equipment, should give way to a comfortable chair. Many kitchen tasks, it was found, can be performed with less expenditure of energy and greater comfort when seated in a chair than when sitting on a stool.

In a study of some of the new methods of automatically heating water by electricity, the Virginia station found that fully 50 percent of the cost of energy and operation might be saved by better insulation and regulation and by various other simple improvements. Investigations of electric ranges by the same station showed the need of more accurate and reliable oven-temperature regulators. The station has also shown ways in which the efficiency and cost of operation of electric irons may be greatly improved.

Fabrics, Clothing, and Laundering

In view of present conditions any contribution to the selection of textile fabrics from the standpoint of durability, fastness of color to light and laundering, and relation of price to quality is particularly timely. A number of experiment stations have made important contributions to this subject.

In a study of white cotton fabrics of cord and plain weave at different prices, the Ohio station found the higher-priced fabrics to be finer and lighter in weight but not necessarily any stronger. The cord-weave fabrics showed less uniformity in strength than the plain weave, a point of considerable importance in wearing quality.

In a study of wash silks such as are used for outer garments, the Ohio station found price to be closely correlated with quality. The higher-priced silks, both pure dye and weighted, were stronger, heavier, and thicker, and contained less weighting and water-soluble finishing material. The weighted silks were not so strong as the pure-dye silks and decreased more in strength when exposed to light. They showed, however, an increase in strength when laundered, possibly as a result of shrinkage.

In a study of the effect of sunlight on the durability and color of cotton fabrics, the Texas station found guaranteed fabrics to be less affected by sunlight than those not guaranteed. Length of exposure and atmospheric conditions proved to be much more important factors in the deterioration of the fabric than were differences in the fabrics themselves.

Many disease germs remain virulent in clothing for considerable periods of time. The Washington station has found that ordinary methods of washing rayon or silk underwear eliminate less than half of the germs. Drying indoors and outdoors in the sunshine eliminates approximately 99 percent. Ironing with a warm iron eliminates approximately 100 percent. The station, therefore, recommends ironing of the garments after outdoor or indoor drying, to prevent skin infection. If the garment cannot be ironed without danger to the fabric, the use of a germicidal or fungicidal rinse is suggested.

Gainful Occupations of Rural Women

A study of gainful occupations among Rhode Island women, begun by the Rhode Island station before the period of depression but continued into it, showed a great variety of ways in which women contribute to family income in that State and revealed comparatively slight effect of business depression on such activities. Such investigations have shown that in many cases it has been the home maker's cash income alone that has enabled the family to weather the present financial situation. Information on the amount of assistance the home makers are re-

ceiving in the customary home-making duties, through help in household tasks, labor-saving equipment, and substitute services, suggests that these women are carrying their wage-earning occupations as an extra burden.

Improvement of Social Life in Rural Communities

Organized effort is becoming more and more essential in providing rural communities with proper facilities for social life. Much of the success of such effort depends upon developing community clubs or organizations that are well adapted to the new relationships that have come into existence largely through better means of transportation and communication, and are best fitted to meet the diverse attitudes of members and to develop efficient leaders.

In a study of community organizations the Virginia station found that, even in well-developed communities, long-established organizations have the active support of less than one third of those whose support they seek, and that notwithstanding the great improvement in transportation facilities the larger proportion of the membership live within 2 miles of the community centers. One organization, including all interests of the community, rather than separate organizations for different interests, was favored by a majority of the members, and two thirds of the members favored only one organization meeting a month.

In a study of rural community clubs in North Dakota the experiment station of that State found the major factors influencing the distribution of clubs to be stimulation and direction from outside the community, imitation of contiguous areas having successful clubs, social solidarity in the area, and the nationality of the population. Permanency of such clubs was found to depend on, among other things, a relatively stable population; tolerance and respect for the attitudes, beliefs, customs, and interests of individuals and groups; wise and unselfish leadership; and activities sufficiently diversified to interest all groups.

In a study of local rural leadership the Washington station found the activities during adolescence that were considered most influential in training for leadership to be speaking, parliamentary practice, debating and preparing papers in school, literary societies and community clubs, athletics in schools, and committee work in community clubs.

The importance of effective community organizations was shown in a study of factors affecting the attitudes of rural people toward such organizations, which was completed during the year by the Virginia station in cooperation with the Federal Farm Board.

Improvement in rural community relationships is brought out in studies recently reported by the Wisconsin station.

Isolation, the age-old handicap of the farmer, is rapidly disappearing. Improved facilities of travel are making the farmer and his family less dependent on any one local community and are putting them onto the main highways of social and commercial activities.

TAXATION AND USE OF TAX RECEIPTS

Farm taxation has been studied by nearly half of the experiment stations, in most cases in cooperation with the Department of Agriculture. Such investigations have brought together many data on the actual workings of the tax systems of different States, the tax burdens on farm real estate and other types of property, the expenditures of different governmental units and for different purposes, the inequalities in the levies and assessed valuations, and similar topics. The findings are providing reliable bases for revising taxing systems, fixing levies, equalizing assessments, and allotting tax receipts. Among the stations recently reporting taxation studies are those of Delaware, Kansas, Minnesota, Missouri, New Jersey, Oregon, South Carolina, Texas, Virginia, and Wisconsin.

Inequalities in taxation.—Inequalities in taxation in Texas indicated by studies recently reported by the Texas station are ascribed to "the failure to tax intangible personal property, and the failure to assess properties at uniform and comparable values", suggesting the need for drastic changes, not only in methods of assessment but also in the fundamental principles of the tax system—such changes as broadening the base of tax structure

so as to include a personal income tax to be substituted for taxes on intangible personal property, and reduction of the general property tax by the amount of revenue derived therefrom; selection of county assessors on the basis of competitive examinations under Civil Service rules; provision for central control and supervision of assessment by a State tax commissioner or commission; and requiring that much greater emphasis be placed on the technique of assessing individual properties.

Similar inequalities and possible means of correcting them were brought out in investigations recently reported by the South Carolina station. These investigations confirmed the view that ability to pay is the most equitable basis for taxation and that net income is a satisfactory measure of ability to pay.

Sources and uses of tax funds.—In studies of the taxation system of Virginia and the use made of tax receipts, the Virginia station found that both county and city governments obtain about 65 percent of their tax revenue from the real-estate tax. Nearly one half of the total receipts of the counties was used for school purposes, about one fourth for roads and bridges, and the remainder for other functions of the county governments. Ordinary county expenditures have increased during recent years, but extraordinary expenditures (from loans for building roads, bridges, and schoolhouses) have decreased sharply. It is thought that the results of this study will be useful in improving the taxation system of the State.

From a study of taxation with special reference to schools, the Oregon station reached the conclusion that there is an unnecessarily complicated and confusing public-school-revenue system in Oregon and that a simpler law would be more effective in raising adequate revenue and equalizing the school-tax burden.

Property tax is the chief source of funds for highways in Wisconsin, the Wisconsin station found. The counties of that State spent more on roads than did the State and towns together. In general, the amount of county funds spent on town roads has remained stationary, that spent on county trunk roads has increased, and that spent on Federal and State trunk roads has decreased in recent years, but up to 1929 the counties spent more on State and Federal trunk roads than on the other two types of roads combined. The station estimates that farmers paid 47.7 percent of the money spent on all roads in that State in 1930 and were responsible for only 42.7 percent of the travel on them. The contributions of farmers to highway construction and maintenance represent a tax rate of 10.1 mills on their general property, while those of urban residents represent a rate of only 3.6 mills. "In 1929 the farmers paid only 4.2 percent of the normal income tax, while the urban group paid 95.8 percent."

SERVICE WORK

The primary function of the experiment stations is scientific research, but in addition to strict research, the stations are called upon for various kinds of regulatory, advisory, and other service work, the extent and value of which may not be fully realized. Such service by the trained and experienced technical specialists of the stations is in greatest demand and is especially valuable in times of depression.

So great has the demand for such service become that some of the stations have found it necessary to set up separate divisions to care for it. In many cases, however, most of the burden of such work has fallen on members of the staff already carrying heavy loads of research but who are thereby specially fitted to render the expert service required.

The inspection of fertilizers, feeds, seeds, dairy glassware, and various other agricultural materials, which many stations are called upon to do, is a broad example of useful regulatory and service work. Such work involves not only examination of the materials but study of methods best suited to the purpose; it also involves supplying information on the proper handling and most efficient use of the materials.

Inspecting fertilizers and giving advice on their use played a large and influential part in the early history of the experiment stations. The director of a New England station recently declared that in his opinion analyzing fertilizers and enforcing fertilizer laws was the greatest contribution the experiment stations had made to New England agriculture. Fertilizer inspection has operated not only to eliminate fraud but to improve the grade and quality of fertilizers and to promote their more efficient use.

Many specific examples of helpful service work based on research might be mentioned. For example, the Vermont station, as a result of its long-continued and comprehensive dairy investigations, has been able to give especially effective and timely aid to New England milk producers in their efforts to establish better methods of marketing milk and to work out more satisfactory dairy contracts. A comprehensive inspection and survey of alfalfa seed sold in Colorado, recently completed and published by the experiment station, shows the quality of seed sold in the State and enables the purchaser to know which are the better brands and grades.

The station specialists are frequently called on to investigate outbreaks of plant and animal diseases and insect pests and to suggest emergency measures for their control. In like manner they are called on to furnish facts and advice to educational agencies and other organizations in activities in the interest especially of agriculture and rural life, but frequently of urban life as well. Maintaining in each State such technical agencies prepared to make the accumulated findings of over half a century of scientific research immediately available in the adjustments necessarily under way during the year, merits special emphasis. The service rendered in this capacity is an outstanding contribution of the experiment stations.

INSULAR EXPERIMENT STATIONS

In pursuance of a policy of retrenchment, coordination, and greater local participation in administration, a policy which has been developing for some time, the Department of Agriculture discontinued direct operation of experiment stations in Alaska, Guam, and the Virgin Islands on July 1, 1932. Immediate direction of station work in Alaska was transferred to the Alaska Agricultural College and School of Mines, but, under an extension of the Hatch and supplementary acts, the station continues to receive some Federal support. The physical plant of the Guam station was transferred to the island Government to be used, with local support, as an agricultural school. The Virgin Islands station was transferred to the Department of the Interior. Little change was made in the status of the stations in Hawaii and Puerto Rico, but steps were taken to coordinate all station work in Puerto Rico, as had previously been done in Hawaii.

The incomes of the experiment stations during the fiscal year ended June 30, 1932, were: Alaska, $77,450 (including $15,000 under the extension of the Hatch and supplementary acts); Hawaii, $65,520 (including $22,000 under the extension of the Hatch and supplementary acts); Puerto Rico, $63,560; Guam, $30,200; and the Virgin Islands, $67,315 (including $37,015 transferred from the Department of the Interior).

The Alaska stations, although undergoing considerable reorganization and change of status during the year, continued most of the more important lines of work, dealing with crops, livestock, and types of farming adapted to the varied conditions of the territory, in furtherance of its service in demonstrating the agricultural possibilities of Alaska and showing how they may be developed.

The Hawaii station gave particular attention during the year to utilization of marginal and submarginal lands at different elevations for forestry and other purposes. It also continued previous work with grasses and forage crops, coffee, and various horticultural crops; feeding and management of livestock (including poultry); and Japanese and other foods used in Hawaii.

The Puerto Rico station temporarily discontinued active direction of work in aid of the citrus and pineapple industries, which has been in progress since 1916 and has been very helpful to these industries. The effort to find and extend the use of improved varieties of sugarcane resistant or immune to mosaic disease was continued on an enlarged scale. Work in aid of coffee culture was continued and enlarged, and investigations relating to control of parasites of livestock, which are one of the most serious obstacles to the development of animal production in the island, were continued and extended.

Further progress was reported by the Guam station in improving crop and animal production in the island, through research and extension work, especially in establishing new and better forage plants, extending the culture of vegetables to supply local needs, and in developing coconut culture and the copra industry.

The Virgin Islands station continued work directed especially toward improving varieties and methods of culture of sugarcane, forage crops, fruits, and vegetables suited to the island, and developing animal production and dairying through use of better sires, control of tick fever, and introduction of sanitary methods of dairying. The extension activities were further developed during the year.

CHANGES IN PERSONNEL

The total turnover in station personnel during the year ended June 30, 1932, was a little less than in the preceding year, but there were more changes among the leaders in research

projects. There were 6 changes in directorships, approximately 50 among leaders or heads of departments, and 36 in the rank of associate, including 9 deaths. Shortage of funds was the cause of some of the changes, which in many cases resulted in loss of well-trained, experienced men.

Changes in directorships were as follows: P. S. Burgess, chemist at the Arizona station, was selected as director of that station, succeeding E. D. Ball, who resigned to devote his time exclusively to research in zoology and entomology. G. W. Gasser, professor of agriculture at the Alaska college, was made director of the station, assuming his duties July 1, 1931. In Iowa, C. F. Curtiss retired on June 30, 1932, as director but remained as research professor on the station staff. R. M. Hughes, president of the college, assumed the duties of the directorship pending the appointment of a director. Cornelius Betten, director of resident instruction at the New York State College of Agriculture, was designated to act as director of the Cornell station, replacing A. R. Mann, who became provost of the university. J. T. Jardine resigned the directorship of the Oregon station to become chief of the Office of Experiment Stations in the United States Department of Agriculture, and was succeeded by W. A. Schoenfeld of this Department. T. C. Johnson, director of the Virginia truck station, died March 31, 1932.

PUBLICATIONS OF THE STATIONS (1931–32)

The total number of experiment station publications in the regular series received by the Office of Experiment Stations during the year ended June 30, 1932, was 845, classified as follows: Meteorology, 15; soils and fertilizers, 55; field crops 72; horticulture, 101; forestry, 8; plant diseases, 56; entomology and zoology, 68; foods and human nutrition, 32; rural-home management, 13; animal production, 101; dairying, 25; diseases of livestock, 32; agricultural engineering, 26; economics and sociology, 11; and annual reports and miscellaneous publications, 130. In addition, the stations published in 69 technical and scientific journals 1,437 articles reporting or based on their work, exclusive of 80 articles in the Journal of Agricultural Research contributed or collaborated in by 31 stations.

The stations expended $336,411 for publications during the year, as compared with $371,312 the previous year.

For economy in printing, a complete classified list of station publications, which has been a feature of previous reports, is omitted from this report. Lists of station publications are, however, published weekly in the Official Record, monthly in mimeographed form, and biennially in printed and indexed form as supplements to Department Bulletin 1199.

INCOME, EXPENDITURES, AND OTHER STATISTICS, 1932

By J. I. Schulte

The following tables give detailed data regarding: (1) Personnel, publications, and mailing lists of the experiment stations; (2) revenues and additions to equipment; (3) expenditures from the Hatch, Adams, and Purnell funds; (4) expenditures from the supplementary funds; and (5) total disbursements from the United States Treasury under the Hatch, Adams, and Purnell Acts from their passage to the end of the fiscal year, June 30, 1932.

Table 3.—*Personnel, publications, and mailing lists of the experiment stations, 1932*

Station	Date of original organization	Date of organization under Hatch Act	Persons on staff	Teachers on staff	Persons on staff assisting in extension work	Publications during fiscal year		Names on mailing list
						Number	Pages	
Alabama	February 1883	Feb. 24, 1888	54	21	-------	2	80	3,500
Alaska	———, 1898	----------	6	1	-------	1	22	46
Arizona	----------	———, 1889	43	31	-------	14	632	5,887
Arkansas	----------	———, 1887	50	27	-------	10	492	5,500
California	———, 1875	March 1888	203	99	159	46	2,220	19,967
Colorado	----------	Feb. 29, 1888	69	43	9	12	434	650
Connecticut (State)	Oct. 1, 1875	May 18, 1887	44	-------	-------	18	920	16,610
Connecticut (Storrs)	----------	May 18, 1887	30	10	6	8	267	10,500
Delaware	----------	Feb. 21, 1888	23	7	5	6	244	7,100
Florida	----------	———, 1888	78	3	3	24	802	12,000
Georgia	Feb. 18, 1888	July 1, 1889	28	1	-------	27	222	5,000
Guam	———, 1909	----------	6	-------	-------	-------	-------	-------
Hawaii	———, 1901	----------	18	6	-------	8	271	3,150
Idaho	----------	Feb. 26, 1892	52	24	6	29	501	15,150
Illinois	----------	Mar. 21, 1888	135	80	14	36	1,416	33,592
Indiana	———, 1885	January 1888	118	25	-------	36	781	38,760
Iowa	----------	Feb. 17, 1888	113	56	6	39	716	14,500
Kansas	----------	Feb. 8, 1888	112	75	-------	14	531	13,900
Kentucky	September 1885	April 1888	74	27	5	15	692	14,000
Louisiana	April 1886	----------	53	7	3	13	522	4,543
Maine	March 1885	Oct. 1, 1887	37	4	-------	8	351	17,000
Maryland	———, 1888	April 1888	62	29	7	8	148	32,100
Massachusetts	———, 1882	Mar. 2, 1888	77	10	9	38	484	15,000
Michigan	----------	Feb. 26, 1888	127	73	-------	33	1,510	17,023
Minnesota	Mar. 7, 1885	———, 1888	162	115	7	43	1,369	10,000
Mississippi	----------	Jan. 27, 1888	54	12	-------	9	259	-------
Missouri	----------	January, 1888	87	58	-------	75	1,410	4,938
Montana	----------	July 1, 1893	47	15	6	21	698	5,000
Nebraska	Dec. 16, 1884	June 13, 1887	45	21	-------	20	652	1,365
Nevada	----------	December 1887	18	1	-------	6	178	5,000
New Hampshire	———, 1886	Aug. 4, 1887	48	19	7	20	514	8,000
New Jersey (College)	----------	Apr. 26, 1888	34	} 53	28	69	1,680	17,000
New Jersey (State)	Mar. 10, 1880	----------	[1] 95					
New Mexico	----------	Dec. 14, 1889	26	14	-------	42	356	10,000
New York (Cornell)	———, 1879	April 1888	127	59	1	25	1,690	82,052
New York (State)	March 1882	----------	68	-------	-------	48	1,004	10,000
North Carolina	Mar. 12, 1877	Mar. 7, 1887	48	-------	1	2	72	11,600
North Dakota	----------	March 1890	57	20	2	10	582	8,100
Ohio	Apr. 25, 1882	Apr. 2, 1888	129	37	4	38	2,167	48,905
Oklahoma	----------	Oct. 27, 1890	66	43	-------	11	219	7,000
Oregon	----------	July 1888	93	38	1	58	836	1,778
Pennsylvania	----------	June 30, 1887	126	87	25	24	660	37,000
Puerto Rico	———, 1901	----------	6	-------	-------	3	86	2,414
Rhode Island	----------	July 30, 1888	23	4	-------	13	314	2,000
South Carolina	----------	January 1888	48	10	1	11	457	5,000
South Dakota	----------	Mar. 13, 1887	28	35	2	14	535	5,550
Tennessee	June 8, 1887	Aug. 4, 1887	35	4	-------	9	141	13,728
Texas	----------	Apr. 3, 1889	112	-------	-------	27	1,380	68,720
Utah	----------	———, 1890	44	26	6	10	318	9,500
Vermont	Nov. 24, 1886	Feb. 28, 1888	27	11	1	15	464	4,200
Virginia	———, 1888	———, 1891	49	16	7	12	446	12,000
Virgin Islands	———, 1920	----------	7	-------	-------	-------	-------	-------
Washington	----------	———, 1891	51	23	-------	10	294	15,809
West Virginia	----------	June 11, 1888	52	36	2	15	251	11,662
Wisconsin	———, 1883	———, 1887	120	83	63	6	374	49,109
Wyoming	----------	Mar. 1, 1891	39	18	2	11	280	8,750
Total	----------	----------	3,564	1,517	398	1,122	33,944	781,658

[1] Including 19 who are also on college station staff but not included in total.

TABLE 4.—*Revenues and expenditures*

Station	Revenues						
	Federal			State	Balance from previous year [1]	Fees	Sales
	Hatch fund	Adams fund	Purnell fund				
Alabama	$15,000	$15,000	$60,000	$73,601.22	$45,858.63		$12,891.44
Alaska [2]	15,000						
Arizona [3]	15,000	15,000	60,000	111,213.51			2,681.25
Arkansas	15,000	15,000	60,000	96,603.86			14,237.63
California	15,000	15,000	60,000	1,114,211.22	17,087.65		25,550.26
Colorado	15,000	15,000	60,000	115,385.58	11,042.96		34,268.60
Connecticut (State)	7,500	7,500	30,000	236,928.69		$21,000.00	
Connecticut (Storrs)	7,500	7,500	30,000	39,263.13	1,051.44	10,920.69	4,096.40
Delaware [4]	15,000	15,000	60,000	21,500.00	3,331.65		12,317.22
Florida	15,000	15,000	60,000	330,233.00	16,020.55		14,244.11
Georgia	15,000	15,000	60,000	20,507.19	7,001.73		11,626.15
Guam [2]							
Hawaii [2 4]	15,000	7,000		13,676.35	155.62		16,282.68
Idaho	15,000	15,000	60,000	47,209.18			4,812.40
Illinois	15,000	15,000	60,000	412,599.44			49,501.42
Indiana	15,000	15,000	60,000	276,737.35	148,172.61	83,289.61	59,601.41
Iowa	15,000	15,000	60,000	262,500.00	8,839.78		30,356.02
Kansas	15,000	15,000	60,000	155,500.00	10,933.50	42,424.52	
Kentucky	15,000	15,000	60,000	136,803.24	44,163.58	73,137.43	25,534.43
Louisiana	15,000	15,000	60,000	74,500.00	21,495.28	20,939.69	18,025.41
Maine	15,000	15,000	60,000	35,000.00		13,102.32	10,419.30
Maryland	15,000	15,000	60,000	67,757.09	4,760.26		18,526.39
Massachusetts	15,000	15,000	60,000	177,853.11		79,343.52	9,390.97
Michigan	15,000	15,000	60,000	322,329.62			28,365.31
Minnesota	15,000	15,000	60,000	323,600.87		357.88	69,886.62
Mississippi	15,000	15,000	60,000	19,891.11			13,994.14
Missouri	15,000	15,000	60,000	70,249.27	26,215.28	16,716.48	30,443.19
Montana	15,000	15,000	60,000	111,504.22	161.58		21,360.02
Nebraska	15,000	15,000	60,000	162,347.15			51,728.11
Nevada	15,000	15,000	60,000	4,565.67	361.84		4,583.04
New Hampshire	15,000	15,000	60,000	5,800.00	9,871.24		1,874.30
New Jersey (College)	15,000	15,000	60,000				
New Jersey (State)				587,160.00		45,964.80	85,152.86
New Mexico	15,000	15,000	60,000	7,500.00	30,261.93		13,588.48
New York (Cornell)	13,500	13,500	54,000	872,039.83			53,203.82
New York (State)	1,500	1,500	6,000	463,495.73	4,577.91		8,272.02
North Carolina	15,000	15,000	60,000	101,807.23	5.82		36,353.71
North Dakota	15,000	15,000	60,000	151,080.00	3,500.04		50,081.36
Ohio	15,000	15,000	60,000	878,106.00	218,536.77		56,075.96
Oklahoma	15,000	15,000	60,000	131,811.96	18,772.29		17,012.57
Oregon	15,000	15,000	60,000	118,384.60	67,521.59	4,872.58	42,809.49
Pennsylvania	15,000	15,000	60,000	145,061.79	1,799.06		19,918.97
Puerto Rico							
Rhode Island	15,000	15,000	60,000		196.82		6,012.70
South Carolina	15,000	15,000	60,000	73,787.83			57,679.97
South Dakota	15,000	15,000	60,000	29,969.75	9,046.81		6,122.01
Tennessee	15,000	15,000	60,000	28,011.38	1,126.00		14,799.46
Texas	15,000	15,000	60,000	351,416.00	56,313.16		75,118.36
Utah	15,000	15,000	60,000	81,905.32			12,760.25
Vermont	15,000	15,000	60,000		215.41	22,355.10	1,441.36
Virginia	15,000	15,000	60,000	104,970.00	15,319.15		9,396.84
Virgin Islands [2]							
Washington	15,000	15,000	60,000	76,295.95	5,575.07		41,125.39
West Virginia	15,000	15,000	60,000	66,010.00	457.42		41,461.87
Wisconsin	15,000	15,000	60,000	344,252.85			40,636.85
Wyoming	15,000	15,000	60,000	48,159.81	11,640.92		26,089.12
Total	750,000	727,000	2,880,000	9,501,097.10	821,391.35	434,424.62	1,311,711.64

[1] Not including balances from Federal funds.
[2] Support from direct appropriations to the U.S. Department of Agriculture given under "Miscellaneous."
[3] Additions to equipment estimated.
[4] Including balances: Delaware, $359.49, Purnell; Hawaii, $48.86, Adams.

for additions to equipment, 1932

Revenues—Continued		Additions to equipment						
Miscellaneous	Total	Buildings	Library	Apparatus	Farm implements	Livestock	Miscellaneous	Total
$67,905.60	$290,256.89	$5,880.91	$794.34	$3,870.25	$5,066.34	$460.50		$16,072.34
62,450.00	77,450.00	2,999.88	74.10	5.95	2,801.55		$736.05	6,617.53
	203,894.76	3,836.70	3.87	4,808.40	5,405.15	8,177.97	466.14	22,698.23
1,600.00	202,441.49	3,684.14	1,362.06	8,492.74	6,807.89	2,346.25	1,490.79	24,183.87
46,234.41	1,293,083.54	107,272.85	10,000.00	8,608.29	15,494.94	10,329.96		151,706.04
3,015.00	253,712.14	3,790.00	758.00	5,408.00	2,315.00	2,147.00	933.00	15,351.00
7,712.50	310,641.19	70,665.52	1,474.41	790.77	5,104.37		939.44	78,974.51
100.00	100,431.66	619.75	955.47	524.60	430.64	213.64	1,364.19	4,108.29
	127,148.87		1,308.56	663.34	1,854.90		1,172.13	4,998.93
	450,497.66	11,601.95	2,933.26	2,892.35	12,950.95	1,097.69	4,031.69	35,507.89
	129,135.07	3,200.00	1,334.48	3,500.00	4,000.00	850.00		12,884.48
30,200.00	30,200.00							
43,554.04	95,668.69	2,565.00	232.50	916.77	924.85	3,115.50	807.69	8,562.31
	142,021.58	26,000.00	150.00	300.00	200.00	500.00	200.00	27,350.00
20,291.73	572,392.59	1,534.04				17,309.86		18,843.90
89,894.00	747,694.98	11,388.78	2,198.23	7,857.85	1,457.73	1,568.00	4,370.50	28,841.09
	391,695.80			4,626.10				4,626.10
9,100.00	307,958.02	11,920.07	123.04	2,526.78	10,858.50	3,421.94	2,041.26	30,891.59
28,725.15	398,363.83		270.21	453.90	576.74	463.00	940.68	2,704.53
6,407.89	231,368.27	2,697.74	63.67	607.11	1,834.80	2,044.15	2,215.41	9,462.88
	148,521.62	2,326.87	1,477.64	2,822.04	627.63	84.00	1,654.00	8,992.18
28,861.96	209,905.70	2,399.97	426.77	1,834.25	1,950.78	228.26	711.52	7,551.55
11,355.68	367,943.28		617.01	4,270.59	2,266.69		1,522.84	8,677.13
	440,694.93	431.00	1,328.00	7,496.00	3,705.00	500.00	3,700.00	17,160.00
5,466.00	489,311.37	23,577.12	1,886.05	5,931.72	18,581.26	4,031.03	2,442.77	56,449.95
516.17	124,401.42		77.55	945.69			4,920.87	5,944.11
	233,624.22		1,082.18	6,333.10	1,337.88	435.92	293.86	9,482.94
	223,025.82	7,367.99	570.65	1,103.51	2,857.53			11,899.68
	304,075.26	13,547.35	265.20	9,861.29	5,243.81	14,044.04	646.76	43,608.45
	99,510.55	1,175.45	264.99	1,071.71	188.83	826.00	386.06	3,913.04
33,080.69	140,026.23	1,906.91	775.65	1,419.27	1,879.92	168.85	1,301.55	7,452.15
	90,000.00							
3,000.00	721,277.66	799.00	3,251.82	25,501.60	1,000.00	1,905.00		32,457.42
	141,350.41	540.00	295.55	1,025.22	2,152.27	150.00	2,135.96	6,299.00
12,119.30	1,018,362.95	250,895.21	2,516.86	43,300.09	33,944.13	5,612.52	13,235.82	349,504.63
9,000.00	494,345.66	220,000.00	3,519.18	12,622.20	1,987.70	300.00	55,458.23	293,887.31
3,439.10	231,605.86	12,449.86	476.37	1,340.46	2,642.42	2,505.31		19,414.42
6,980.15	301,641.55	18,841.13	842.52	284.28	5,813.35	5,341.35	601.00	31,723.63
10,069.45	1,252,788.18	45,540.47	1,436.59	1,007.36	5,085.84	7,811.33	336.65	61,218.24
36,543.54	294,140.36	45,770.11	961.96	2,562.35	1,040.63	2,427.06	3,303.40	56,065.51
8,028.54	331,616.80	4,278.33	41.79	3,650.84	3,961.54	581.00	1,883.20	14,396.70
	256,779.82		299.64	1,045.53	6,052.54		856.10	8,253.81
63,560.00	63,560.00	2,042.12	355.72	819.04	406.77	320.00	2,237.25	6,180.90
	96,209.52	4,348.00	621.00	601.00	1,029.00	94.00	1,055.00	7,748.00
	221,467.80	10,037.27	726.06	813.61	1,590.25	1,971.96	2,872.97	18,012.12
3,684.68	138,823.25		310.00	340.00	660.00		220.00	1,530.00
500.00	134,436.84	1,852.28	162.70	2,399.00	1,773.08		680.35	6,867.41
74,816.29	647,663.81	12,887.96	1,902.88	2,976.66	5,555.88	15,351.52	2,223.48	40,898.38
820.00	185,485.57	1,300.00	267.75	1,728.27	1,142.00	2,090.00	1,224.44	7,752.46
	114,011.87	5,061.17	291.44	1,979.98		37.72		7,370.31
	219,685.99	3,714.52	859.79	3,783.78	1,957.65	150.00	3,981.04	14,446.78
30,300.00	30,300.00							
3,564.22	216,560.63	4,474.80	1,843.68	4,556.32	1,283.79	2,996.24	1,313.27	16,468.10
	197,929.29	2,341.63	53.72	1,389.93	3,953.20	5,024.06	2,395.78	15,158.32
56,643.03	531,532.73	154,239.67	1,136.52	5,639.44	3,259.36	3,224.38	2,893.73	170,393.10
	175,889.85	7,907.41	300.00	991.06	2,830.21	1,265.86	146.16	13,440.70
819,539.12	17,245,163.83	1,131,710.93	55,281.43	220,300.39	205,845.29	133,522.87	138,343.03	1,885,003.94

TABLE 5.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures						
		Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies
Alabama	$15,000	$10,561.42	$2,105.33	$296.75	$158.87	$58.83	$15.36	$175.35
Alaska	15,000	3,836.85	3,146.40	37.36	341.52	53.11	147.24	24.04
Arizona	15,000	14,241.01	219.64	224.13	.30			3.11
Arkansas	15,000	7,386.00	3,005.11	1,675.09	221.28	203.49	418.64	236.59
California	15,000	15,000.00						
Colorado	15,000	15,000.00						
Connecticut (State)	7,500	7,500.00						
Connecticut (Storrs)	7,500	7,500.00						
Delaware	15,000	8,519.00	2,113.53	1,185.04	772.08	24.46	416.96	16.84
Florida	15,000	15,000.00						
Georgia	15,000	8,212.50	1,071.50	577.84	557.83	179.56	486.11	25.81
Hawaii	15,000	9,763.55	2,518.75	78.72	143.90	11.99		92.05
Idaho	15,000	8,799.12	3,138.45	936.76	536.45	31.69	7.26	17.48
Illinois	15,000	14,983.26						
Indiana	15,000	15,000.00						
Iowa	15,000	7,950.00	1,057.33	1,115.00	37.66	114.87	154.48	102.02
Kansas	15,000	9,700.00	4,353.72	64.15	129,89			119.17
Kentucky	15,000	14,692.80		238.24				
Louisiana	15,000	6,803.14	5,387.46	1,601.63	32.30	48.44	79.55	138.22
Maine	15,000	9,308.00	2,842.06		182.55	18.86	1,381.82	22.13
Maryland	15,000	14,995.00			5.00			
Massachusetts	15,000	14,729.92						
Michigan	15,000	15,000.00						
Minnesota	15,000	15,000.00						
Mississippi	15,000	10,508.62	1,336.49	29.94	41.07	99.62	479.59	9.79
Missouri	15,000	11,932.61	1,673.97		89.67	81.20	1.36	361.60
Montana	15,000	10,164.75	1,612.48		290.14	16.45	2.13	125.07
Nebraska	15,000	15,000.00						
Nevada	15,000	9,475.02	1,899.41		515.82	.87	264.98	39.82
New Hampshire	15,000	9,539.44	577.19	678.89	1,034.59	321.33	700.00	89.30
New Jersey	15,000	10,195.00	726.33	410,68	356.27	3.42	41.00	90.83
New Mexico	15,000	8,539.62	2,930.95	1,416.04	300.56	49.71	444.29	21.39
New York (Cornell)	13,500	8,310.00	3,385.66		67.41	118.10		319.53
New York (State)	1,500	1,500.00						
North Carolina	15,000	12,972.34	447.99	62.23	148.09	28.09		27.97
North Dakota	15,000	15,000.00						
Ohio	15,000	7,459.98	2,438.71	863.80	120.74	37.89	929.28	1,083.42
Oklahoma	15,000	4,576.77	6,954.62	411.21	52.22	30.07		773.01
Oregon	15,000	8,516.66	4,840.83	441.66	96.53	14.94	172.55	12.88
Pennsylvania	15,000	12,720.00	955.33	1,266.75				
Rhode Island	15,000	6,522.01	3,312.05	1,258.10	524.07	165.21	200.44	156.27
South Carolina	15,000	8,877.42	2,002.44	359.41	469.16	59.35		147.04
South Dakota	15,000	7,681.62	3,531.30	2,332.06	121.67	136.57	20.71	57.70
Tennessee	15,000	9,796.00	1,859.61	270.80	349.40	59.02	7.93	6.59
Texas	15,000	15,000.00						
Utah	15,000	10,175.16	2,238.79	122.75	80.83	29.79	19.30	128.23
Vermont	15,000	9,875.68	830.42	327.06	451.53	12.44	678.91	22.27
Virginia	15,000	8,409.96	5,058.49		59.42	.60	59.58	160.79
Washington	15,000	11,518.66	1,295.71	1,077.10	9.48			116.32
West Virginia	15,000	7,100.82	5,058.80	9.72	58.15		15.09	330.35
Wisconsin	15,000	14,955.32			1.01			
Wyoming	15,000	7,453.66	4,941.47	206.87	270.71	64.06	247.83	233.27
Total	750,000	543,258.69	90,868.32	19,575.78	8,628.17	2,074.03	7,392.39	5,286.25

the act of Mar. 2, 1887 (Hatch Act), for the year ended June 30, 1932

Classified expenditures—Continued

Seeds, plants, and sundry supplies	Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Traveling expenses	Contingent expenses	Buildings and land	Balance
$147.07	$61.00	$533.15	$383.79	$259.29	$35.31	$9.08		$199.40			
314.70	400.50		74.10	2,801.55	736.05	5.95		80.75		$2,999.88	
18.35				3.50				289.96			
754.82	37.19	757.06	37.31	84.69	23.15	111.68	$42.90		$5.00		
251.95	118.40		1,035.41	43.25	225.35			223.13	54.60		
715.47	35.85	979.54	273.49	1,001.64	399.65	1.50	5.40	383.32		92.99	
350.80		1,161.45	5.50	360.10		7.20	77.50	414.49		14.00	
164.21	18.15	155.20		245.17	55.06	50.50	60.00	780.65	1.95	1.90	
											$16.74
440.83	18.26	3,729.28		40.80		130.98		108.49			
26.20				5.27	27.00	35.99		338.98	13.14	186.49	
								68.96			
255.96	208.42			259.95		.82		177.31		6.80	
184.85		422.90	106.25		1.36	1.93		527.29			
								270.08			
551.56	561.60	226.70	9.84	589.96			5.00	397.26	18.22	134.80	
30.25	2.00	112.70	205.59	55.77		323.25		126.88	3.15		
119.03		1,127.09	77.83	227.18	603.67	45.97	5.00	581.53	1.68		
432.52		873.16	217.61	212.15	123.75			456.84	169.60	318.45	
125.70	35.70		595.94	91.17	512.75	139.27		526.53	32.20		
331.54	149.80	360.00	202.19	55.46	264.63	657.25	10.00	1,027.28	78.38	39.94	
474.16	81.40			370.11		128.01		14.84		228.92	
113.41	118.80			58.57	4.50	1,004.02					
129.13	37.35	1.60	63.92	55.94		37.44		765.61	72.30	150.00	
560.73	189.50	410.00		664.47	54.58	40.90		104.90	41.10		
1,103.77		457.92	11.08	109.18	17.55	32.15	110.59	350.68		9.18	
214.15				90.64	83.15			507.81	8.20		
18.82	39.10										
770.08	99.65	200.05	237.97	375.26	136.84	109.38	8.82	293.25		630.55	
452.12	204.47	325.00	710.06	354.40	292.08	4.98		489.77		252.30	
323.63	.40	265.55		191.49	24.30		1.40	187.69	2.17	121.74	
141.48	50.48		481.10	1,264.45	223.95	41.81		194.17	6.42	246.79	
495.13		966.84	75.04	89.78	195.35	37.59	19.50	308.95		16.97	
168.80	88.90		96.95	168.42	855.39	497.20		160.80	147.65	617.58	
239.22	235.24		15.48	168.47	19.60	88.96		82.19		402.00	
122.11	23.50		5.00	18.89	13.70	318.84		455.69		25.00	
280.23		1,052.80	15.22	293.15	5.50	91.40	6.60	660.67	21.50		
								43.67			
368.85			1.00	830.10	63.43	5.34		193.94	2.38	117.09	
11,191.57	2,815.66	14,117.99	4,937.67	11,440.22	4,997.65	3,959.39	352.71	11,793.76	679.64	6,613.37	16.74

TABLE 6.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures						
		Salaries	Labor	Postage and stationery	Freight and express	Heat, light water, and power	Chemical supplies	Seeds, plants, and sundry supplies
Alabama	$15,000	$11,493.21	$503.98	$12.25	$48.15	$104.73	$1,187.70	$115.34
Arizona	15,000	10,935.84	2,048.00	18.15	56.05		276.47	152.19
Arkansas	15,000	9,200.00	2,169.77	5.45	77.87	41.01	1,050.23	413.75
California	15,000	15,000.00						
Colorado	15,000	15,000.00						
Connecticut (State)	7,500	7,500.00						
Connecticut (Storrs)	7,500	7,500.00						
Delaware	15,000	11,933.00	1,432.14	6.45	24.65		813.11	138.54
Florida	15,000	15,000.00						
Georgia	15,000	10,207.50	1,636.07	74.98	350.44	254.52	648.97	81.86
Hawaii	7,000	4,965.00	1,219.55		11.14		304.37	5.63
Idaho	15,000	12,191.61	1,363.27	3.37	5.02		235.52	197.36
Illinois	15,000	13,155.00	1,845.00					
Indiana	15,000	13,641.70	322.45	1.52	3.88		523.96	3.81
Iowa	15,000	8,680.00	3,349.18	102.14	131.02	184.07	767.86	484.34
Kansas	15,000	10,300.00	3,997.79	18.20	10.00		390.63	2.99
Kentucky	15,000	14,895.00	26.40			24.72	7.13	
Louisiana	15,000	11,438.33	1,420.38	19.26	41.52	47.31	531.02	85.00
Maine	15,000	15,000.00						
Maryland	15,000	14,433.35		2.30			243.28	3.57
Massachusetts	15,000	15,000.00						
Michigan	15,000	15,000.00						
Minnesota	15,000	15,000.00						
Mississippi	15,000	10,320.00	3,028.37	19.90	54.81	247.68	824.84	192.20
Missouri	15,000	3,144.81	5,774.73	99.77	163.91	64.04	1,276.26	421.20
Montana	15,000	12,425.72	980.64	11.58	12.38		502.15	102.26
Nebraska	15,000	15,000.00						
Nevada	15,000	9,234.16	3,638.52	112.58	16.27		106.18	66.16
New Hampshire	15,000	12,880.00	606.40	9.48	8.05		214.32	128.47
New Jersey	15,000	11,317.50	473.70	58.78		934.05	1,358.31	232.67
New Mexico	15,000	9,370.59	2,770.66	32.06	173.85	480.49	644.33	163.43
New York (Cornell)	13,500	12,350.00	606.94	19.42	1.86		306.90	44.92
New York (State)	1,500	1,500.00						
North Carolina	15,000	12,500.89	402.24	4.64	17.69	130.36	401.15	172.68
North Dakota	15,000	15,000.00						
Ohio	15,000	9,900.00	4,743.79	92.31			84.53	88.42
Oklahoma	15,000	9,000.00	2,080.86	14.31	25.82		983.61	464.04
Oregon	15,000	12,332.00	1,594.43	11.19	13.85	128.57	472.00	108.03
Pennsylvania	15,000	14,500.00	383.14				41.99	18.80
Rhode Island	15,000	11,216.43	2,057.78	14.44	20.29	148.16	127.56	117.85
South Carolina	15,000	11,174.32	1,005.45	208.36	37.83	173.64	142.32	373.59
South Dakota	15,000	7,478.24	4,680.94	23.50	74.43		180.29	323.26
Tennessee	15,000	12,473.76	286.10	12.76	38.46	48.28	354.35	19.02
Texas	15,000	14,700.00	200.00		3.75	1.04	49.88	21.98
Utah	15,000	9,300.00	3,210.00	32.60	27.05	812.78	837.71	144.66
Vermont	15,000	9,775.94	3,344.30	25.11	15.50	58.03	461.72	130.68
Virginia	15,000	12,999.87	1,275.36		1.25		109.79	15.22
Washington	15,000	12,860.35	1,471.24	79.99			196.18	19.34
West Virginia	15,000	10,663.28	2,413.15	3.16		49.57	194.51	291.71
Wisconsin	15,000	12,815.00	2,185.00					
Wyoming	15,000	11,799.77	1,334.52	12.75	83.63		975.72	110.77
Total	727,000	585,502.17	71,882.24	1,172.76	1,550.42	3,933.05	17,826.85	5,455.74

the act of Mar. 16, 1906 (Adams Act), for the year ended June 30, 1932

Classified expenditures—Continued									
Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Traveling expenses	Contingent expenses	Buildings and land
			$79.29	$3.00	$1,400.41		$51.94		
$13.50			8.06	10.33	351.63		964.36	$24.11	$141.31
137.58	$466.67	$152.34	238.52		743.93	$14.00	268.88		20.00
		34.02	9.90	1.50	365.95		240.74		
	737.47	24.66	133.20	4.50	293.22	35.00	54.79		462.82
	74.90	17.04	14.45		387.92				
			68.83	288.15	353.52	107.00	171.55	14.80	
	153.15				339.53				
2.15	630.82	1.00	36.63	16.85	601.11		12.83		
	34.29		4.95	150.00	41.80	32.65			16.70
	46.75								
	811.24	7.50	10.00		418.41	4.32	165.71		
		8.00			190.85		118.65		
		5.00	230.74	50.07	15.00	2.00		1.64	7.75
	2,055.49		594.71		974.71	257.00		9.00	164.37
	15.70		25.78	84.41	113.70	13.50	712.18		
	970.06		2.25	33.30	110.57	461.00	248.95		
	243.63		335.97		145.96		89.72	18.00	320.00
.61		8.49	56.01	20.00	62.40		311.10	70.43	95.95
96.98		3.20	374.44	93.46	422.64				373.87
53.00			15.70		101.26				
32.90	25.76		49.21	211.35	644.54	48.08	358.51		
			39.35		27.60	24.00			
27.30	1,196.15	7.80	185.32		900.56		6.60		107.63
	1.11	5.53	111.15	8.00	140.45		73.69		
			18.50				37.57		
185.51	752.63		116.04		53.07	5.00	21.15		164.09
50.00		.60	1,037.70		216.83		279.42	1.60	298.34
37.26	107.80	27.87	543.00	84.49	534.88		892.35		11.69
6.00		38.19	200.80	78.20	1,207.41		173.23		63.44
	20.85							2.50	
		12.60	48.15	60.00	139.53		173.84		201.08
40.30		55.23	52.18	44.57	873.67	9.00	110.68		3.15
	89.40		30.70	122.33	318.96		37.12		
8.85					78.05		286.00		
	197.85		440.58		678.32	5.00	62.87		
	55.25		61.66		39.70	85.00	401.98		39.25
691.94	8,686.97	409.07	5,173.77	1,364.51	13,288.03	1,102.55	6,326.41	142.08	2,491.44

TABLE 7.—*Expenditures from United States appropriations received under*

	Amount of appropriation	Classified expenditures							
		Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds, plants, and sundry supplies
Ala	$600,00	$42,635.67	$7,552.44	$422.02	$344.62	$186.34	$655.16	$2,317.42	$318.03
Ariz	60,000	40,950.72	6,094.91	535.89	94.76	367.06	118.71	2,406.83	684.51
Ark	60,000	48,384.58	2,889.41	2,817.61	591.87	94.70		726.70	409.20
Calif	60,000	60,000.00							
Colo	60,000	49,032.36	3,325.37	1,099.93	289.01	373.95	6.48	732.71	210.49
Conn. (State)	30,000	23,905.28	2,583.39	8.62	161.32	58.88		768.23	343.53
Conn. (Storrs)	30,000	24,018.66	1,641.04		844.27	10.67			2.90
Del	60,000	41,592.00	7,072.23	1,585.78	192.90	62.02	792.36	670.74	635.60
Fla	60,000	39,978.69	8,747.74	1,240.34	199.09	7.37	52.54	3,018.80	995.05
Ga	60,000	35,723.56	8,345.45	313.48	377.93	1,171.81	1,439.47	1,381.47	698.37
Idaho	60,000	42,706.62	5,700.58	998.53	370.24	177.21	349.36	1,356.35	573.92
Ill	60,000	39,034.42	4,742.30	5,264.44	1,605.05	111.10	20.69	426.04	268.90
Ind	60,000	43,280.06	4,279.00	1,042.89	282.58	220.30	30.45	149.35	623.39
Iowa	60,000	36,634.90	9,622.36	121.53	494.61	307.46	665.13	1,800.23	2,623.32
Kans	60,000	30,000.00	23,384.54	90.25	25.29	17.42	5.84	991.23	314.82
Ky	60,000	53,025.83	2,562.82	825.26	152.92	30.35	31.80	445.75	124.23
La	60,000	40,920.00	10,181.50		690.76	199.50	351.39	324.40	667.34
Maine	60,000	43,436.04	3,564.99	19.63	318.71	197.71	558.36	918.79	832.32
Md	60,000	46,114.91	6,048.68	4.50	102.53	10.98	7.23	969.83	541.19
Mass	60,000	49,933.11	3,675.01	520.92	245.36	34.06	19.15	429.77	632.13
Mich	60,000	43,173.87	8,539.31	1,085.40	444.20	14.85		447.03	164.15
Minn	60,000	54,238.40	470.51	898.17	53.52	25.79		270.33	231.39
Miss	60,000	43,003.90	6,391.82	604.37	885.84	217.23	1,079.47	624.59	906.32
Mo	60,000	25,582.00	14,108.54	1,032.20	697.75	566.01	94.20	4,204.82	1,264.78
Mont	60,000	36,825.20	12,234.36	752.05	189.08	165.82	123.00	805.52	779.16
Nebr	60,000	38,046.73	8,168.06	1,010.33	130.27	42.74	2.64	482.02	507.30
Nev	60,000	32,643.80	16,620.49	1,470.78	750.11	231.14	189.79	760.20	739.12
N.H	60,000	44,770.76	4,621.52	1,619.12	287.66	103.03	21.94	719.62	937.09
N.J	60,000	43,692.50	6,564.87	27.67	182.80		209.85	1,852.88	428.91
N.Mex	60,000	31,073.10	9,917.69	1,059.27	999.14	889.72	563.44	190.03	3,273.94
N.Y. (Cornell)	54,000	43,361.43	858.48		623.52	10.00		434.84	29.01
N.Y. (State)	6,000	5,655.00						164.32	
N.C	60,000	43,005.94	6,327.08	819.39	381.01	113.20	133.13	867.99	575.89
N.Dak	60,000	53,555.58	565.49	1,574.60	242.98			440.61	416.11
Ohio	60,000	37,906.95	10,100.69	2,971.07	42.26		1,434.87	217.06	259.72
Okla	60,000	32,952.13	13,386.95	327.92	226.66	34.61		1,951.96	854.76
Oreg	60,000	38,303.47	6,837.72	3,330.37	302.72	96.55	318.24	619.63	1,048.36
Pa	60,000	43,191.54	7,251.03	1,146.46	348.94	108.26	502.47	494.70	384.92
R.I	60,000	40,986.72	8,758.86	787.25	502.02	159.48	1,016.41	424.77	766.01
S.C	60,000	44,524.78	3,156.40	1,034.03	611.80	417.15	229.57	831.43	498.27
S.Dak	60,000	31,949.46	14,206.50	2,789.27	662.44	243.78	45.22	967.55	864.50
Tenn	60,000	46,607.03	3,774.37	136.62	121.75	304.31	292.48	1,198.24	604.58
Tex	60,000	40,720.00	14,254.45		461.09	155.74	107.73	666.93	658.44
Utah	60,000	34,551.02	14,012.04	794.30	719.51	166.78	22.50	767.56	799.95
Vt	60,000	31,990.69	10,976.25	3,209.80	623.48	148.42	3,034.22	988.39	550.42
Va	60,000	41,764.87	8,991.10	1,973.84	124.69	4.07	27.15	265.32	173.79
Wash	60,000	42,090.70	8,198.48	1,027.95	178.18	76.57	21.45	1,137.86	1,136.21
W.Va	60,000	45,018.75	5,269.03	30.00	7.03	53.96	57.09	952.26	1,598.49
Wis	60,000	46,537.50	11,486.19		18.93			716.82	23.50
Wyo	60,000	38,560.35	8,332.78	905.42	220.20	449.79		523.93	573.29
Total	2,880,000	2,007,591.58	366,394.82	49,329.27	18,463.40	8,437.89	14,630.98	44,823.85	32,547.62

the act of Feb. 24, 1925 (Purnell Act), for the year ended June 30, 1932

Classified expenditures—Continued

Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Traveling expenses	Contingent expenses	Buildings and land	Balance
$22.85	$831.26	$107.88	$401.80	$160.55	$2,038.88	$18.50	$1,284.97	$681.45	$20.16	
739.31	725.07	3.87	859.28	455.81	1,826.76		3,719.89	10.07	406.55	
11.51	284.58	527.90	177.00	51.25	1,532.12	36.00	1,427.49	25.65	12.43	
	991.88	5.75	230.65	128.60	501.94	177.85	2,266.13	69.76	557.14	
135.21			945.90	144.54	318.25		508.96	89.20	28.69	
		171.49		517.72			2,753.25			
145.04	1,638.15	88.30	872.86	686.35	111.35		3,252.46	133.04	468.82	
465.87	413.10	39.00	360.88	1,197.48	981.70	82.50	1,519.29	6.25	694.31	
787.71	2,278.96	81.65	1,099.08	1,730.37	704.73	156.10	2,914.05		795.81	
	856.36	147.01	437.00	645.34	554.18	39.50	3,866.65	28.95	1,192.20	
	471.51	11.34	1,956.86	732.53	2,299.72		2,941.81	45.20		$68.09
	203.82		23.09	137.80	2,793.20		6,913.15	20.92		
108.18	3,814.98	1.85	439.91	130.66	513.66	543.86	1,903.02	271.09	3.25	
	316.75		702.12	217.19	1,121.64	928.50	1,125.70	543.89	214.82	
	498.09	43.00		66.27	76.68		2,117.00			
185.24	1,685.07		966.50	54.01	55.47	1,672.66	1,252.20	509.96	284.00	
20.15	1,706.34	97.01	1,135.97	228.91	1,516.38	43.50	4,554.30	530.50	320.39	
513.55		18.69	219.79	178.55	1,497.21	76.76	3,673.28		22.32	
6.50	104.71	59.39	182.28	738.61	331.34	204.03	2,804.67	26.83	52.13	
	532.98	121.71	121.50	517.33	179.92		4,623.24	34.51		
	684.94		255.00	487.36	622.63	44.43	1,567.53	150.00		
9.90	2,000.46	39.07	1,965.26	183.41	37.30	522.50	1,470.60	18.50	39.46	
18.10	4,063.89	107.46	927.21	139.76	2,883.58	579.97	1,727.45	169.45	1,832.83	
82.40	19.71	31.18	1,238.81	65.50	943.84	107.50	5,636.87			
	4,170.01	51.65	111.31	331.04	1,154.96	309.75	2,514.21	12.15	2,954.83	
127.45	1,394.09	19.25	482.23	232.10	155.83	588.72	3,094.52	40.00	460.38	
537.50	290.84	29.26	366.64	217.59	759.41	166.85	3,653.60	74.08	823.49	
.60	622.23	501.97	1,899.17	605.98	778.91	48.50	2,064.32	100.48	418.36	
59.50	2,630.61	12.84	963.61	2,017.80	550.82	920.19	3,447.75	43.75	1,386.80	
	228.98	18.56	131.59	1,973.48	525.24		225.37	5,565.00	14.50	
			69.34		111.34					
196.84	3,156.10			640.85	565.86		2,921.15	295.57		
	462.12		11.55		358.15		2,263.81	109.00		
55.70	3,870.01		21.00	128.84	218.13	1,112.06	702.49		959.15	
26.93	4,514.23	14.25	1,018.10	742.52	951.63	782.86	2,043.62	99.00	71.87	
2.40	390.16	23.06	2,900.19	477.63	2,034.37	6.00	3,199.84	62.23	47.06	
84.80	1,399.50		1,002.03	334.71	746.71	186.75	2,817.18			
488.21	657.41	347.00	1,229.64	387.22	439.42	80.67	815.61		2,153.30	
64.28	1,871.05	5.00	1,056.84	574.50	576.11	690.50	3,757.07		101.22	
14.58	1,151.42	282.75	1,046.14	420.67	1,250.25	342.01	3,268.86	.42	494.18	
43.17		383.05	453.49	694.72	1,548.33	26.53	1,023.54		2,787.79	
	392.46	133.77	166.48	243.51	513.20	168.50	682.38	367.30	308.02	
87.60	152.00	146.39	101.25	304.70	1,021.47	225.00	5,475.94	4.00	647.99	
234.27	697.91	78.27	1,588.80	1,371.19	609.17		1,817.06	255.23	1,826.43	
2.21	365.98	9.80	695.68	713.53	690.46	41.25	4,144.86		11.40	
23.04	76.78	74.45	1,612.24	779.83	854.19	213.55	2,440.14		58.38	
873.87	3,013.69	10.20	123.20	21.00	341.01	194.00	1,398.42		1,038.00	
							1,217.06			
	5,183.48	147.97	1,938.45	109.94	664.01	357.13	2,030.51	2.75		
6,174.47	60,813.67	3,993.04	34,507.72	22,919.25	40,861.46	11,694.98	122,843.27	10,396.18	23,508.46	68.09

TABLE 8.—*Expenditures from supplementary funds received from within the States for the year ended June 30, 1932*

State	Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds, plants, and sundry supplies	Fertilizers	Feedstuffs
Alabama	$98,896.78	$13,254.99	$1,092.87	$1,813.41	$1,896.91	$7,590.91	$563.92	$6,516.92	$3,503.45	$4,129.10
Arizona	51,367.95	16,018.77	4,846.79	1,452.88	507.98	670.37	2,117.15	2,418.89	2,483.85	1,125.10
Arkansas	54,250.00	20,984.82	323.74	2,416.50	914.60	3,140.72	4,558.40	1,658.20	1,936.38	1,813.59
California	441,531.66	198,508.78	26,588.15	19,730.57	8,180.97	24,061.67	23,580.48	47,281.18	9,143.44	61,477.57
Colorado	55,818.39	26,188.62	3,038.08	3,204.35	3,247.27	3,590.26	7,491.21	4,200.32	16.89	6,389.03
Connecticut (State)	104,433.46	109,540.41	455.52	2,701.20	304.70	6,889.27	1,714.44	2,813.94	906.99	243.26
Connecticut (Storrs)	25,227.35	16,785.46	98.94	1,354.93	395.58	714.11	2,405.42	909.05	238.00	392.23
Delaware	5,747.00	12,507.44	----------	1,058.75	497.85	2,636.51	9.83	3,666.20	472.13	2,909.30
Florida	175,479.40	56,914.17	5,026.75	6,524.23	2,007.48	12,373.66	6,029.99	10,453.85	4,709.94	7,240.46
Georgia	4,054.85	4,304.73	924.75	562.27	500.60	1,381.88	425.25	1,119.11	926.60	1,325.74
Hawaii	11,672.91	5,002.68	----------	822.00	86.37	703.49	1,465.40	2,930.80	723.12	3,663.50
Idaho	18,803.48	6,516.89	1,859.21	969.64	261.51	725.95	380.00	2,869.70	----------	5,875.19
Illinois	260,972.26	107,721.10	13,913.02	4,650.89	----------	----------	9,502.65	19,119.79	3,778.16	24,844.28
Indiana	247,770.46	107,222.72	5,830.55	23,768.84	3,009.07	12,240.06	25,706.44	6,726.96	6,355.64	21,505.32
Iowa	208,819.67	23,834.22	9,028.61	3,510.85	1,017.17	1,491.99	4,992.51	14,905.86	449.54	3,218.47
Kansas	41,486.43	63,925.16	2,182.65	3,158.27	1,772.54	5,063.35	1,686.34	6,060.53	147.70	10,193.71
Kentucky	149,931.18	62,440.91	1,481.57	4,040.32	1,497.04	6,645.05	2,893.02	12,523.67	369.49	6,607.68
Louisiana	82,278.60	30,025.57	502.66	1,380.39	1,590.41	2,189.32	1,094.37	2,675.47	1,430.99	1,487.93
Maine	21,505.92	16,375.44	89.76	746.40	960.40	2,835.46	576.83	2,418.50	1,380.87	1,414.04
Maryland	51,921.75	29,702.86	1,544.11	1,320.75	1,480.77	2,102.05	1,430.68	3,964.55	1,283.14	7,102.32
Massachusetts	108,458.91	43,529.03	2,646.69	2,237.97	1,509.21	1,622.24	4,464.87	4,523.17	749.45	2,910.51
Michigan	155,075.35	88,120.95	19,816.71	2,981.89	2,252.67	2,787.54	7,217.94	14,651.15	2,272.54	12,397.87
Minnesota	180,523.64	77,367.24	13,151.40	6,388.51	2,876.90	17,393.82	16,738.97	183.02	----------	16,001.72
Mississippi	----------	1,895.35	34.08	179.96	328.30	167.35	170.13	646.84	4.79	139.00
Missouri	50,585.75	19,723.55	10,066.36	2,493.56	1,555.68	1,684.13	3,986.55	3,505.06	66.53	6,183.56
Montana	62,859.02	26,497.03	2,108.54	2,291.81	371.99	4,057.55	944.41	5,818.96	320.27	7,512.98
Nebraska	87,217.66	31,057.73	3,151.44	1,920.01	1,342.99	5,139.22	4,885.20	4,016.00	8,666.05	26,733.84
Nevada	132.60	93.25	----------	147.09	17.30	1,861.85	78.24	146.45	----------	40.00
New Hampshire	21,451.84	5,620.55	983.61	782.29	105.48	----------	567.68	1,966.28	----------	260.77
New Jersey	382,619.84	24,318.70	22,987.81	14,923.67	2,037.32	15,001.86	17,379.25	2,506.89	4,540.70	53,659.46
New Mexico	8,700.96	5,479.34	56.08	174.17	446.15	403.66	47.23	658.59	----------	1,246.01
New York (Cornell)	388,208.35	59,956.87	22,806.94	9,875.97	1,575.70	24,886.21	12,331.91	12,743.16	7,123.96	9,696.78
New York (State)	170,515.36	34,998.81	8,766.39	2,990.29	1,138.40	9,749.98	12,178.35	8,030.99	1,759.63	597.30
North Carolina	54,053.98	32,271.86	42.45	6,764.89	1,102.61	5,533.71	360.89	1,719.68	7,285.24	11,041.46
North Dakota	63,083.30	20,946.05	5,352.32	1,870.77	16,752.95	9,071.70	13,702.96	7,115.79	15.10	20,601.92
Ohio	321,163.56	128,197.16	34,791.20	4,135.77	3,064.05	22,613.56	3,619.42	23,757.43	2,928.94	19,713.84
Oklahoma	82,616.65	17,454.55	1,040.94	1,756.59	638.35	73.82	6,171.88	1,097.39	----------	3,882.48
Oregon	105,777.74	25,163.54	2,067.58	1,673.67	798.69	4,430.96	3,349.48	5,025.38	109.63	6,132.20
Pennsylvania	84,474.51	30,044.91	3,653.74	3,023.74	1,381.87	3,179.75	3,643.73	7,353.72	1,424.37	9,539.95
Rhode Island	308.34	2,272.19	138.88	50.46	68.95	131.19	72.44	191.99	1.20	186.55
South Carolina	37,762.19	22,799.49	1,034.61	1,172.82	643.56	3,865.63	172.69	5,285.10	3,064.95	11,900.14
South Dakota	18,074.19	6,250.85	1,261.65	312.78	296.24	252.36	181.91	1,574.22	73.74	5,690.78
Tennessee	21,831.83	8,331.95	187.78	738.42	552.20	1,186.93	21.88	2,123.67	120.67	2,976.69
Texas	244,639.68	82,020.15	11,258.97	9,942.53	2,807.30	10,823.32	4,965.34	17,600.93	1,336.40	10,341.91

Utah	31,998.80	23,429.11	1,131.51	2,548.30	479.01	10,777.24	557.65	4,272.78	123.50	3,094.52
Vermont	6,529.65	8,058.91	1,328.86	615.71	81.12	543.70	364.11	376.30		2,548.97
Virginia	59,045.45	14,830.54	4,972.15	2,534.58	522.32	668.03	975.06	3,541.20	1,522.97	4,290.65
Washington	48,294.57	37,331.75	18.79	1,560.44	550.70	2,989.32	1,921.40	5,599.53	418.35	9,012.42
West Virginia	33,827.50	29,931.03	2,634.67	1,396.60	1,236.98	3,927.18	683.18	12,098.32	1,384.30	6,381.53
Wisconsin	181,028.42	81,242.02	11,038.32	5,298.39	3,367.34	9,051.42	9,713.72	19,427.44	3,411.50	28,699.63
Wyoming	27,676.94	11,861.54	148.37	320.44	684.26	417.99		5,462.36		5,882.95
Total	5,150,506.08	1,928,871.74	267,506.57	178,291.53	80,715.81	271,339.30	230,092.80	338,253.28	88,981.10	472,256.21

TABLE 8.—*Expenditures from supplementary funds received from within the States for the year ended June 30, 1932*—Continued

	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Travel expenses	Contingent expenses	Buildings and land	Balance	Total
Alabama	$302.67	$4,325.96	$133.94	$421.88	$442.00	$6,151.99	$1,430.80	$5,860.75	$41,927.64	$200,256.89
Arizona		4,593.03	6,559.09	2,630.01	8,177.97	4,740.07	579.08	3,388.84	216.94	113,894.76
Arkansas	519.07	5,761.83	863.28	4,332.85	1,881.23	2,440.11	1,164.25	3,481.92		112,441.49
California	4,812.33	31,039.56	8,180.97	11,068.37	22,136.74	43,551.62	14,677.62	81,809.68	125,722.18	1,203,083.54
Colorado	752.19	2,085.26	1,037.89	3,739.72	1,964.32	9,638.67	863.69	3,233.23	27,212.75	163,712.14
Connecticut (State)	1,918.61	6,282.11	1,004.05	565.77	4.71	8,721.32	2,686.73	3,151.96	11,302.74	265,641.19
Connecticut (Storrs)	856.53	430.64	674.98	524.60	213.64	2,408.22	6.75	619.76	1,175.47	55,431.66
Delaware	150.83	1,343.77	258.93	186.04		327.01		2,569.30	2,807.98	37,148.87
Florida	2,894.26	12,617.34	2,834.21	2,901.65	1,015.19	12,041.28	1,224.80	10,907.64	27,301.36	360,497.66
Georgia	954.68	3,010.30	315.47	102.46	684.29	1,080.30	1,011.25	6,903.48	9,547.06	39,135.07
Hawaii		859.91			200.00	72.07	1,109.78		189.66	29,501.69
Idaho	17.27	1,412.19	902.52	172.90	39.80	3,124.08	1,385.31	3,108.29	3,597.65	52,021.58
Illinois	1,073.21	7,005.87	1,834.85	2,445.31	4,950.62	12,862.44		7,718.14		482,392.59
Indiana	2,198.23	10,578.83	4,232.70	4,725.12	1,568.00	22,621.94	13,675.98	11,388.78	126,569.34	657,694.98
Iowa	17.00	724.88	555.94	2,216.64	322.31	9,773.45	1,283.25	309.96	15,223.48	301,695.80
Kansas	123.04	10,146.16	1,647.07	1,327.35	2,460.79	6,927.53	4,313.87	11,502.06	43,833.47	217,958.02
Kentucky	1,607.71	2,301.58	733.97	545.20	1,081.12	13,030.31	3,947.50	31,794.94	4,891.57	308,363.83
Louisiana	56.17	2,522.49	397.54	132.11	408.67	6,747.42	1,231.04	3,018.13	2,198.99	141,368.27
Maine	1,274.38	2,217.70	328.36	1,350.39	40.50	1,937.04	473.83	755.52	1,840.28	58,521.62
Maryland	408.08	1,749.70	532.97	1,160.09	151.50	3,299.19	6,184.43	2,377.65		117,716.59
Massachusetts	617.01	2,266.69	1,522.84	2,754.94		8,103.02	22.00	2,013.24	87,991.49	277,943.28
Michigan	1,462.73	8,374.23	935.18	7,241.63	4,665.18	16,104.14	982.66	3,354.57		350,694.93
Minnesota	1,886.05	18,326.26	1,955.41	5,309.09	3,986.60	8,106.79	5,538.83	23,577.12		399,311.37
Mississippi	13.00	1,483.60	6.85	3.52	1,243.15	339.13	11.65	740.16	9,952.96	17,359.82
Missouri	769.13	2,121.68	154.10	2,151.56	4,534.17	3,410.40	559.01	3,823.63	26,249.81	143,624.22
Montana	461.64	2,112.80	244.46	236.21	2,050.30	1,041.88	30.00	7,367.99	6,697.98	133,025.82
Nebraska	265.20	5,243.81	646.76	9,861.29	14,044.04	2,162.39	1,322.04	6,399.59		214,075.26
Nevada	183.43		647.44		100.80	1,052.13	1,202.28	412.50	3,368.19	9,483.55
New Hampshire	150.45	1,086.14	571.21	374.63	2.00	4,304.88	455.27	1,436.42	10,506.73	50,626.23
New Jersey	3,371.82	13,985.75	2,485.18	38,682.50	2,297.50	25,750.04	32,751.45	48,969.08	1,444.87	709,713.69
New Mexico	253.51	894.01	24.70	24.25	66.78	336.29	656.91	286.29	31,595.48	51,350.41
New York (Cornell)	2,498.30	33,738.27	11,257.84	41,669.57	5,612.52	38,962.93	3,536.96	250,880.71		937,362.95
New York (State)	3,519.18	1,987.90	819.45	443.85	300.00	4,307.58	500.00	16,780.22		279,383.68
North Carolina	412.45	2,559.01	513.53	92.62	2,505.31	8,622.48	2,901.32	3,594.16	228.21	141,605.86
North Dakota	728.52	4,891.29	429.95	441.20	5,248.39	3,915.70	3,908.04	16,761.61	16,803.99	211,641.55
Ohio	1,436.59	4,549.49	153.23	720.73	5,480.40	13,640.90	7,303.14	51,145.57	454,345.72	1,102,760.70
Oklahoma	977.73	1,318.57	511.39	2,019.42	9,702.51	8,432.26	7,663.91	46,769.63	12,012.29	204,140.36
Oregon	13.20	3,573.87	618.99	288.25	575.00	5,519.45	14,226.18	4,253.77	58,019.22	241,616.80
Pennsylvania	629.78	4,149.06	1,073.67	1,462.88	2,925.76	6,757.47			2,060.91	166,779.82
Rhode Island	36.26	125.71	67.30			318.53	715.40	1,400.07	124.06	6,209.52
South Carolina		6,244.35	67.50		1,531.06	4,219.22	900.40	10,297.15	3,846.88	114,807.74
South Dakota		1,112.23	62.17	21.00	3,928.80	1,582.48	57.16	498.88	7,591.81	48,823.25
Tennessee	10.06	1,529.65	96.72	10.50	390.05	519.94	2,213.66	1,594.24		44,436.84
Texas	1,769.11	9,221.16	1,979.97	2,463.46	15,183.02	28,864.22	22,302.35	24,587.34	55,556.65	557,663.81

Utah	679.93	2,913.11	787.39	190.37	2,730.30	4,979.44	645.12	4,147.49		95,485.57
Vermont	151.99	244.97	125.27			2,528.26	98.18	269.78	346.09	24,211.87
Virginia	897.13	5,974.54	3,619.22	3,796.09	819.00	6,353.07	158.21	7,258.89	7,906.26	129,685.36
Washington	1,764.23	1,481.03	519.74	1,962.41	3,418.19	4,324.96	157.83	5,234.97		126,560.63
West Virginia	28.30	3,096.27	409.28	179.20	2,798.88	1,790.48	1,986.50	1,303.63	2,835.46	107,929.29
Wisconsin	1,942.74	12,362.92	3,323.19	5,475.00	9,050.00	18,102.84	4,441.35	34,556.49		441,532.73
Wyoming			2,700.20		823.76	1,105.21	2,933.59	7,751.07	18,121.17	85,889.85
Total	46,865.73	267,977.48	71,358.86	168,424.63	153,756.87	407,054.57	177,431.36	781,366.29	1,263,164.79	12,344,215.00

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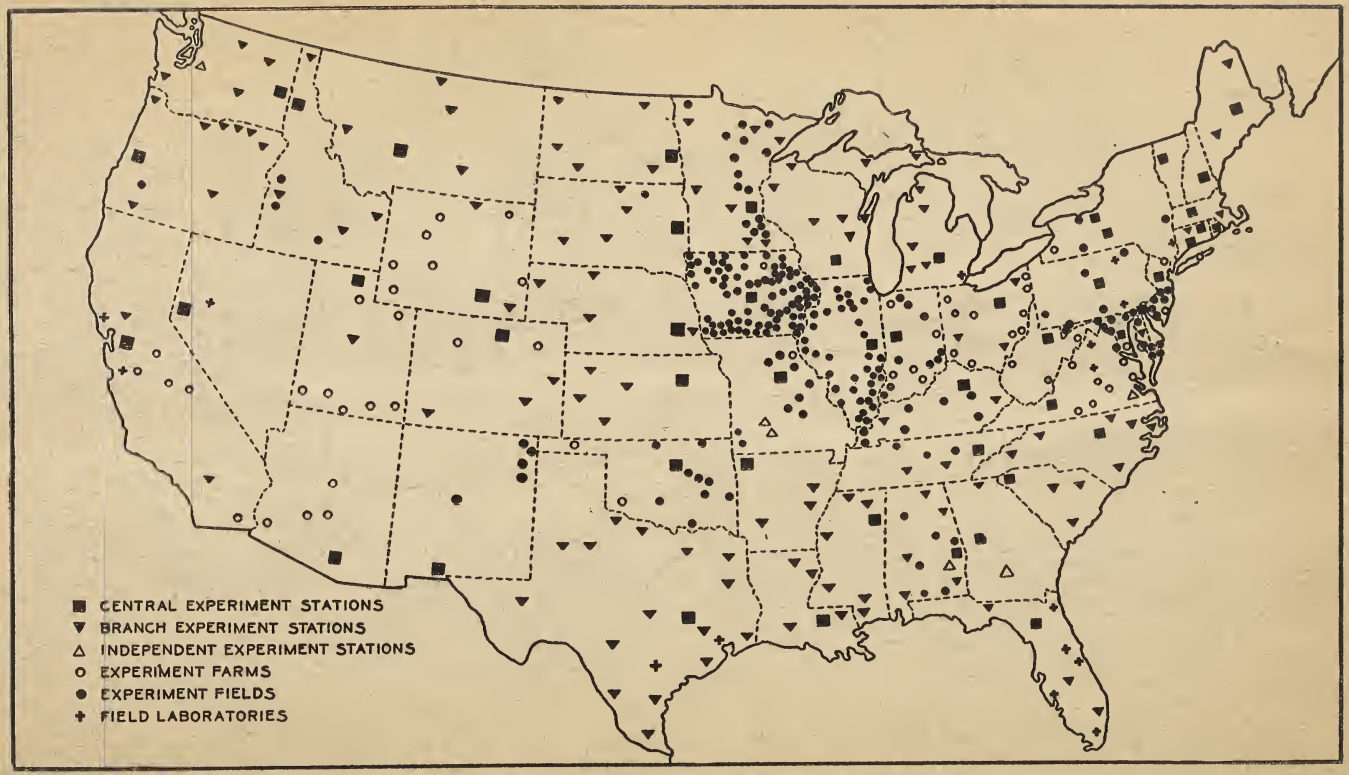

LOCATIONS OF STATE EXPERIMENT STATIONS, SUBSTATIONS, AND EXPERIMENTAL FIELDS

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